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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1241

Washington, D. C. ▼ July 29, 1924

HOW THE UNITED STATES CAN MEET ITS PRESENT AND FUTURE PULP-WOOD REQUIREMENTS

By

EARLE H. CLAPP, Assistant Forester, and CHARLES W. BOYCE, Forest Examiner, Forest Service

Prepared in cooperation with the American Paper and Pulp Association and the Committee on the Perpetuation of the Pulp and Paper Industry in the United States

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REASONS FOR INQUIRY: ITS SCOPE.

Few, if any, of the great national problems confronting the American people are more urgent or important than that of adequate timber supplies. The products derived from our forests are so extensive and varied and contribute so vitally to national life that the entire public is concerned. Directly or indirectly the problem affects every industry regardless of the nature of its products, even those industries which produce the chief competitors of wood, such as cement and steel. Among all industries, however, the problem concerns most obviously and directly those, including pulp and paper, which manufacture their products from wood as the raw material.

For a number of reasons the problem of timber supply for pulp and paper manufacture has become more serious than it is for most wood-using industries. Relatively large plant investments make it much more difficult for paper mills to follow the retreating timber stands than is the case with lumber manufacture. Comparatively few woods have been used in paper making. These factors and the requirement, in one of the most important pulp processes, of abundant and cheap power have so far confined the production of paper to but few timber regions. Pulp manufacture in these regions has in general followed lumbering, and starting with diminished supplies of timber has reduced them still further. A stage has now been reached where many pulp and paper mills have either no timber of their own or only very limited amounts, and few have permanent supplies. Concern for future pulp-wood supplies and their relationship to the entire national forest problem led the American Paper and Pulp Association to form a special "Committee on the perpetuation of the pulp and paper industry in the United States." The committee requested the Forest Service to make an investigation, the results of which are incorporated in this report.

For the past 30 years or more the United States has imported pulp wood from Canada. For some time the volume of these imports was small; but it grew rapidly, particularly during the decade following 1900. For the past 10 years, however, pulp-wood imports have remained at substantially the same level. Fundamentally we have imported pulp wood because our own supplies of material tributary to the existing paper mills have been reduced, while our requirements for paper, pulp, and pulp wood have been expanding. The Canadian pulp and paper industry has shown a phenomenal development during the last decade, and for a number of years it has become increasingly evident that Canadian requirements will in time absorb the pulp wood which is now shipped to the United States. The fact that pulp-wood imports have been practically at a standstill for an entire decade and may now be on the brink of a decline from purely economic causes, accentuates the problem of adequate future sources of raw material which demands attention from the American pulp and paper industry and from the American public. The problem demands attention regardless of the recent action of the Canadian Parliament in giving the governor in council authority to restrict pulp-wood exports. It demands attention regardless of the recommendations which may be made by a Canadian commission now investigating the situation, or of the action which the Canadian Government finally takes. The Canadian situation, like the American, is the result of economic forces long operative and certain to continue, with important consequences for the pulp and paper industry in both countries, irrespective of their traffic in pulp wood.

Although of great importance, pulp-wood imports form only about 19 per cent of our pulp-wood consumption and about 11 per cent of the pulp wood needed to meet our entire paper requirements. During the past decade, while pulp-wood imports have been stationary, imports of both paper and pulp from

Canada and from a number of north-European countries have continued to expand. This expansion has been necessary to meet American requirements for paper. Our paper requirements have in fact grown faster than, under existing conditions, pulp wood could be obtained from our forests or paper and pulp could be produced in our mills. Our pulp and paper imports now constitute an equivalent of 42 per cent of the wood utilized in our total paper consumption, or nearly four times the imports of pulp wood alone. Even without the pulp wood they swell our imports to a greater proportional volume than in the case of any other major forest product. The exceedingly rapid growth and present volume of pulp and paper imports, in themselves alone, more than justify an inquiry into the present situation and the future outlook.

A satisfactory investigation can not therefore be confined exclusively to pulp-wood resources or to pulp-wood imports, and any emergency which might grow out of their reduction, or to paper and pulp imports. Much larger questions of trade and public policy are involved than how, if necessary, to meet a reduction of pulp-wood imports or how to keep present capital investments profitable through the discovery of domestic pulp-wood supplies. It is necessary to deal with the entire situation, with imports of paper and pulp as well as of pulp wood, and with the underlying forces which have brought about these imports. It is most necessary of all to consider just what are our present and possible future pulp-wood resources.

The scope of this investigation has therefore been planned to include:

(1) Present American pulp-wood, wood-pulp, and paper requirements, and the character and extent of our imports from Canada and other countries.

(2) Probable future paper and pulp-wood requirements.

(3) Whether we should attempt to become entirely self-supporting in the part of our paper requirements derived from wood.

(4) Existing timber resources and how we can meet from them our present raw-material requirements for the paper industry.

(5) How we can grow on our own forest lands pulp wood of satisfactory species in sufficient quantities to meet our future requirements.

(6) Supplementary measures essential to the solution of both present and future problems.

Neither time nor funds have permitted the collection of new field data. It has accordingly been possible only to compile, analyze, and interpret with especial reference to the purpose of this investigation the data already available.

WHY WE SHOULD SEEK INDEPENDENCE IN PULP-WOOD SUPPLIES.

The question naturally arises whether we should try to meet all of our future paper requirements from domestic sources. Our economic relations with Canada are close and it is to the mutual advantage of both countries that they should so continue. Canada has a large forest area and much more timber of pulp species in her eastern Provinces than has the United States in the corresponding region. Why should not the United States acquiesce in a permanent dependence on Canada for pulp and paper to supply our densely populated Eastern States now that we have ceased to manufacture sufficient quantities from domestic timber? Why should we not also continue to secure the present or even larger amounts of pulp and paper from north-European countries?

The question turns on the economic advantages or disadvantages to the United States of the alternative courses. There are outstanding reasons for creating a permanent domestic pulp and paper industry which can meet our entire needs, founded on home-grown timber. As will be shown in a subsequent

section, no reliance can be placed upon raw materials other than wood for the great bulk of future paper supplies.

From the standpoint of national interest we obviously should not allow ourselves permanently to remain subject to the losses occasioned by the stoppage of imports of a product so essential to our national life as pulp wood. The possible stoppage of foreign pulp and paper supplies, from any one of a number of causes, would be equally objectionable to our industries, and would also work serious public hardship. In case of a permanent stoppage of such imports, the time within which they could be replaced at home becomes a factor of great importance. With domestic timber available we might enlarge our pulp and paper industry to almost any extent required within 10 years at the most, but to grow the timber needed would require from 20 years under the most favorable conditions to 40 or 50 years in some of our forest regions.

Both the quantity and the price of foreign pulp and paper are becoming increasingly dependent upon world-wide competition. Wood pulp is manufactured very largely from coniferous species. A recent study of the world's timber supply [2] shows that coniferous species supply nearly half of the timber cut in the entire world, but that they occupy only a little more than one-third of the world's area of forest land. Furthermore, the current growth of conifers is less than four-fifths of the cut. The critical world's timber-supply problem of the next half century at least will center in the coniferous forests.

While the general demand for coniferous timber has been expanding to a total which exceeds the replacement by growth, the world's paper consumption has also been increasing with unbelievable rapidity. The world paper consumption curve in Figure 22 gives the appearance of a distorted vertical scale, until one realizes that the phenomenal rate of increased consumption in the United States has been approximately doubled by that of all countries combined. Along with this rapidly expanding world demand must be taken into account the limited amounts which other countries can supply. Sweden is already removing the full annual growth from her forests and Norway is overcutting hers. The Finnish forests as a whole are being overcut. Many observers foresee the limit of the expansion of the eastern Canadian industry. Apparently the only country in the world outside of the United States which offers the opportunity for a long sustained increase in pulp-wood supplies commensurate with the increasing world demands is Russia, including Siberia, and a large part of the Russian forests are inaccessible.

A reconstructed Europe will need more paper than it can purchase now. New paper markets are being created. The reawakening of the Near East and the Orient, the development of Latin America, the settlement of the parts of the world heretofore unoccupied, are all accompanied by increased requirements for paper. If, therefore, the United States elects to depend upon foreign supplies, we must look forward to increasing world competition, higher prices, and restricted amounts in years to come, even though there is no conscious effort by foreign countries or industries to shut off our imports or control their prices.

The part of our own land area which is valuable only for timber production should be used in ways which will contribute most largely to our national prosperity. Regions with large areas of forest land can be made centers of the same permanent development as areas of rich agricultural lands. Both produce crops which differ only in kind. A thriving timber-growing industry is as basic in its character as agriculture. Upon timber crops can be founded permanent local wood-using industries, such as pulp and paper manufacture. Timber growing and its dependent wood-using industries can supply the livelihood for a large rural population of the character that adds so greatly to national strength.

[2] Forest Resources of the World, by Zon and Sparhawk.

Extensive areas of idle forest lands are a public burden. As long as they remain idle, transportation facilities can not be supported, the taxes on productive property are increased, settlement is hampered, and social progress is retarded.

The desirability of becoming independent of foreign countries for pulp wood, pulp, and paper rests fundamentally, however, upon the possibility of growing pulp wood and manufacturing pulp and paper more cheaply than foreign products can be imported. The feasibility of domestic production must in the last analysis rest upon cheaper products to the ultimate consumer.

European pulp-wood supplies now come from cultivated forests. Canadian supplies will soon also have to be grown by forestry if they are to remain a factor of importance. Upon large areas in the United States suitable only for timber growing occur many species eminently satisfactory for pulp. The United States has on the whole much more favorable growing conditions than either eastern Canada or northern Europe, the main sources of our imports. We should therefore be able to secure larger yields in shorter periods from our own land. Upon foreign-grown materials now and in the future, the American consumer must in general pay higher freights than from our own territory. We have forest land and pulp species in abundance, and in addition are more favorably situated than any other country in the world for the remaining essentials of paper making. Water power is available in large quantities. Coal deposits will furnish supplemental power wherever needed. Such other materials as sulphur, caustic soda, limestone, and the bleaching chemicals may be secured within our borders. The alum and rosin needed for "sizing" and the clays for "loading" paper are all domestic products. Since timber is the only material used in pulp and paper making which may be lacking, it should be to the advantage of the final consumer in cheaper products to grow the timber and manufacture pulp and paper at home. Finally, the more nearly independent we can become the less likely we are to be subject either to dictated prices from outside sources or excessive prices resulting from world competition.

For the period during which paper or its constituent materials can be obtained more cheaply by American consumers from foreign than domestic sources, their importation is a sound measure of forest conservation. They will eke out our diminishing supply of convertible pulp wood. But looking forward to the coming world-wide shortage of these materials, with its reactions upon cost and upon the policies of foreign nations, the only sure way to supply our future paper requirements abundantly and cheaply is to utilize our own natural advantages for producing them on American soil.

Since the significance of all these considerations is magnified by the economic importance of the services which paper renders, this question is next discussed.

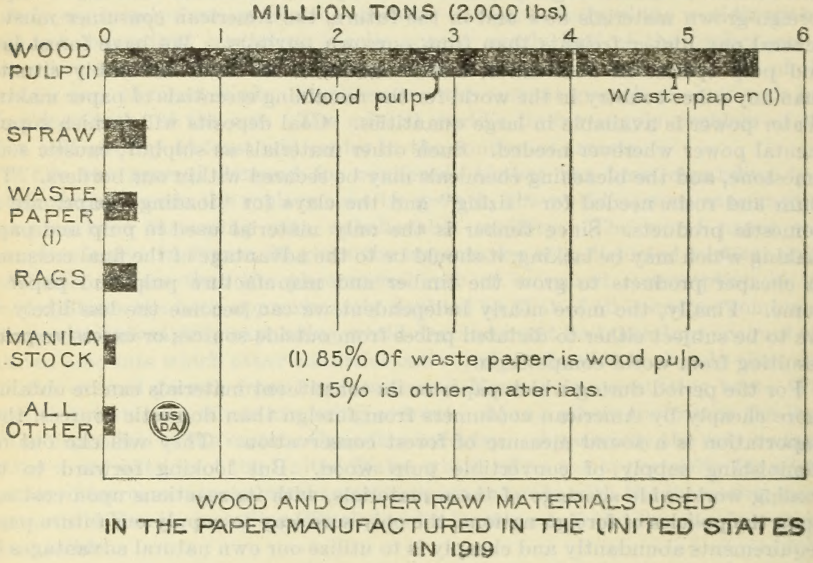
CURRENT AMERICAN REQUIREMENTS: HOW THEY ARE SUPPLIED.

CURRENT REQUIREMENTS AND THEIR IMPORTANCE.

In 1922 the people of the United States consumed more than 8 million tons of paper, more than all other countries in the world combined. In the manufacture of this total the industries of the United States and of several other countries utilized about 5,847,000 tons of new wood pulp, which in turn was secured from about 9,148,000 cords of pulp wood. (Table 1.) In addition the United States reused in its own mills in 1919, the last year for which data are available, slightly in excess of 1,850,000 tons (Table 2) of waste paper, in which wood pulp constituted 85 per cent of the raw material.

Consumption of nonforest materials, though important for specialized products, is relatively small. We used in paper manufactured in the United States in 1919 slightly more than 275,000 tons of rags, 115,000 tons of manila stock, 350,000 tons of straw, and 105,000 tons of all other nonforest materials. How insignificant in volume all these materials are in comparison with wood in present-day paper manufacture is shown graphically in Figure 1.

The importance of continued supplies of raw material for paper must be measured not by the drain of the paper industry upon the forests as compared with that for lumber, fuel wood, and other timber products, but by the part that paper plays in our national life. Newsprint paper has for many years been made exclusively of wood pulp. Our 1922 consumption of more than 2,450,000 tons of newsprint (Table 3) constituted 31 per cent of our total paper requirements. Book paper derives more than 75 per cent of its raw material from the forest, and in 1922 comprised more than 12 per cent of our total paper consumption.



WOOD AND OTHER RAW MATERIALS USED IN THE PAPER MANUFACTURED IN THE UNITED STATES IN 1919

FIG. 1.—Wood supplied over 90 per cent of the raw material for the paper made in the United States in 1919. Wood pulp, which leads all other materials, is supplemented to an important extent by waste paper, 85 per cent of which is derived from wood.

While the bulk of paper consumption is for purposes distinct from its outstanding function as material for the printing press, it is on abundant and cheap supplies of print paper that the interest of the public is now overwhelmingly centered. Cheap newsprint has made it possible for the press to attain its present commanding place in our national life as an agency for the diffusion of information and the creation of an enlightened public opinion on important questions. Book paper, constituting as it does the medium for most magazines as well as books, plays a part in public education the importance of which is obvious and fundamental.

But newsprint and book papers make other contributions to current life. The structure and conduct of modern business in all of its infinite ramifications depends in no small degree upon the facilities afforded by paper and printed material. The fine papers, with a consumption in excess of 350,000 tons, very largely writing papers, may also be classed with newsprint and book in their economic and public benefits.

The widely varied group of papers classified under boards consumed in 1922 a volume almost equaling newsprint, 27 per cent of the total for the year. Its services have merely been more recent and possibly less spectacular than those of the printing and writing papers. Its uses range from the small, highly specialized packages used in the distribution of food and other products to the heavy, strong material which plays such an important part in making our homes more comfortable. Wrapping paper, which in 1922 passed the million-ton mark, finds also a wide range of usefulness for business purposes and is scarcely less essential to the public health for the more sanitary handling of food.

The wide range and varied uses of "all other" papers in everyday civilized life is barely suggested by naming a few of those which constitute the group: Blotting, hanging, fiber, carbon, copying, tissue, fruit wrapping, crêpe, wax, onion skin, oiled, cigarette, insulating, manila, imitation parchment, novelties, cartridge, cork, stencil, leatherette, carpet felting, grease-proof, tar, and building paper. The demand in 1922 for these and other papers of the "all other" group aggregated in excess of 1 million tons.

THE DEVELOPMENT OF THE AMERICAN INDUSTRY.

Pulp and paper making in the United States, and in fact throughout the world, falls into two well-defined periods. During the first no wood at all was used, while during the second wood has supplied an increasingly large percentage of the raw material. The first period persisted until the late sixties of the past century.

PRIOR TO THE USE OF WOOD.

Paper making in the American Colonies is reported to have begun with a mill in Philadelphia, first operated in 1690. The shutting off of European paper during the Revolution greatly stimulated development and at its close the number of mills had increased to 80 or 90. By 1810 there were approximately 200 mills in the United States, and by 1850 there were 443. The early mills were small affairs employing but few hands and ordinarily supplying only local demands. One of the best in the Colonies in 1775, nearly 100 years after the first was built, reported a daily output of from 230 to 250 pounds of paper, contrast enough with the 1,600 times greater capacity of a modern newsprint plant which can produce 200 tons a day.

Colonial paper consumption was very small. Publication of the first newspaper began in 1704. The volume of correspondence hardly justified the existence of the small, unorganized colonial posts. Paper and books were luxuries even for the well-to-do. Approximately 3,000 books, pamphlets, etc., mostly small and with limited editions, are estimated to have been printed in all the Colonies up to about the time of the Revolutionary War, and the number of newspaper issues, none of which exceeded a few thousand copies, was approximately the same. The whole range of paper use was in fact exceedingly meager and restricted compared with that we now know.

As contrasted with paper production in American mills of more than 7 million tons in 1922, the output of 1810 is estimated at 3,000 (Table 4). By 1819 production had more than quadrupled, while during the last century it has increased approximately five hundred sixtyfold. The Civil War with its stimulus for news tripled the paper production of 1859 to the 386,000 tons of 1869. This marks the end of the period during which paper was made exclusively of other materials than wood. The final output was only 5 per cent of that of American mills in 1922 and a still smaller part of our consumption during the latter year.

Until 1859 linen and to a lesser extent cotton rags were the outstanding raw material for paper making in the United States as in Europe. All linen consumed

in the United States was imported, and there were periods of great scarcity during which the mills were unable, despite the most energetic measures, to obtain the rags needed to meet their requirements. This was reflected by serious paper shortages. During the Revolution American officers were often unable to obtain the insignificant amount of paper needed for orders. Newspapers were frequently published on paper of different colors and on sheets of different sizes, and editors were sometimes forced to print even the margins. Then and later colonial, State, and congressional legislative committees made special inquiries; there were a long series of appeals to the public to preserve rags for paper making, prizes were offered to stimulate research for other raw materials, and patents were issued for pulping cornstalks and many other materials. A process by which straw could be utilized for paper was perfected in 1825, but it was little used until Civil War requirements increased consumption by leaps and bounds.

As in practically all early industry, paper manufacture was largely by hand. Until approximately 1825 man power was used except in the beating engines which were gradually introduced, and for these water supplied the power. The various types of machinery which make possible production on its present scale were introduced in primitive form between 1825 and the middle of the century, so that by 1850 paper consumed in the United States was very largely machine made.

THE WOOD-PULP PERIOD.

Although the soda and mechanical processes of making pulp from wood were introduced into the United States during the late sixties and the sulphite process was discovered in 1867, none of these processes was extensively used until after the expiration of patent control 17 years later. The first sulphite mill began operations in 1882 and the first sulphate mill as recently as 1908. A brief statement of the nature of the pulp processes will be helpful to the reader not thoroughly familiar with pulp and paper manufacture.

In the soda, the first of the three chemical processes introduced, chipped wood is cooked in a solution of sodium hydroxide. Under this process the comparatively short-fibered hardwoods, such as aspen, yellow poplar, basswood, and the gums, are reduced. Soda pulp is used almost exclusively in book and the fine papers, to give body. The mechanical, sometimes called the groundwood, process introduced about the same time is based upon an entirely different principle. It reduces such coniferous woods as the spruces and true firs by abrasion against a rapidly revolving stone. Mechanical pulp is used mostly to give body to newsprint and similar papers, and because of its comparatively low cost and the large percentage used, helps to keep the prices of these papers at a low level.

The sulphite was the second chemical process to come into use. It depends upon a cooking solution of bisulphite of lime and produces long-fibered pulp from such woods as the spruces, the true firs, and the hemlocks. This pulp is used to give the requisite strength to newsprint, book, and the fine papers. Sulphite finds, therefore, the most general use of any of the wood pulps.

The third chemical process, the sulphate or kraft, is very recent in application. It uses sodium hydroxide and sulphide in cooking, and from the hard pines, larches, etc., produces a very strong pulp, the standard use of which is for wrapping paper, but which also is an important constituent of boards.

Because of the nature of the solution ordinarily used the soda and sulphate are sometimes called the alkaline processes and the sulphite the acid process. The so-called pulp grades take their names from the particular process—soda, sulphate, sulphite, or mechanical—employed in making them. It is upon these four pulping processes that the growth of paper production in the wood-pulp period is based.

Pulp wood made its first appearance in the census reports of 1869, but contributed only a little more than 2,000 cords to the raw materials used that year in manufacturing approximately 386,000 tons of paper. (Tables 4 and 5.) Before the end of the next 20 years the great growth of the American industry had begun and by 1889 paper output of the mills had passed 930,000 tons. It doubled again during the following decade, and more than tripled between 1899 and 1922.

In short, paper making in great volume became possible with the use of wood. Wood-pulp processes revolutionized both paper making and paper use in the United States and in the whole world. The rapid increase in world paper production since 1895, shown in Figure 2, is based on wood. But while the wood-pulp industry in the United States developed at a phenomenal rate and paper production increased in quantities previously undreamed of, consumption of paper increased still more rapidly. The slowly increasing consumption prior to 1880 and the transformation that followed, especially after 1890, are brought out by Figure 21.

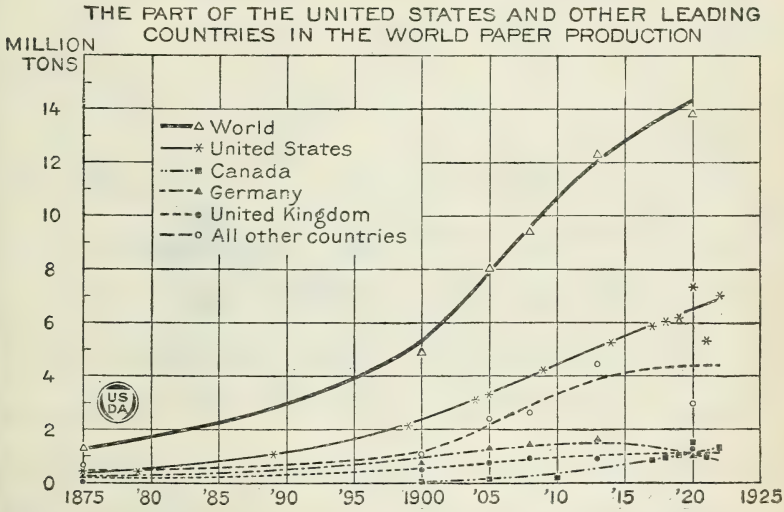


FIG. 2.—The United States in 1920 manufactured more than half of the world's paper, and has in fact led all other countries in production for virtually the entire period for which data are available.

Notwithstanding the great size attained by the American pulp and paper industry in comparison with those of other countries it has developed to a remarkable extent in very restricted regions. The processes now used for both mechanical and sulphite pulp require a soft, light, easily bleaching, long-fibered wood relatively free from pitch. The mechanical process demands in addition the cheap and abundant power which water alone can supply, while for the chemical processes fuel is essential. Nearness to paper markets has been necessary to keep down transportation costs. The spruce forests in New England and New York have met these combined requirements better than those of any other sections of the United States, so that it has been here, and later in smaller degree under similar conditions in the spruce and hemlock forests of the Lake States, that the American industry has largely centered. This development has also carried with it a considerable part of the sulphate-pulp industry, which could have located elsewhere and made use of other species. Even the soda-pulp industry, which began and is now well developed in Pennsylvania, manufactures a large part of

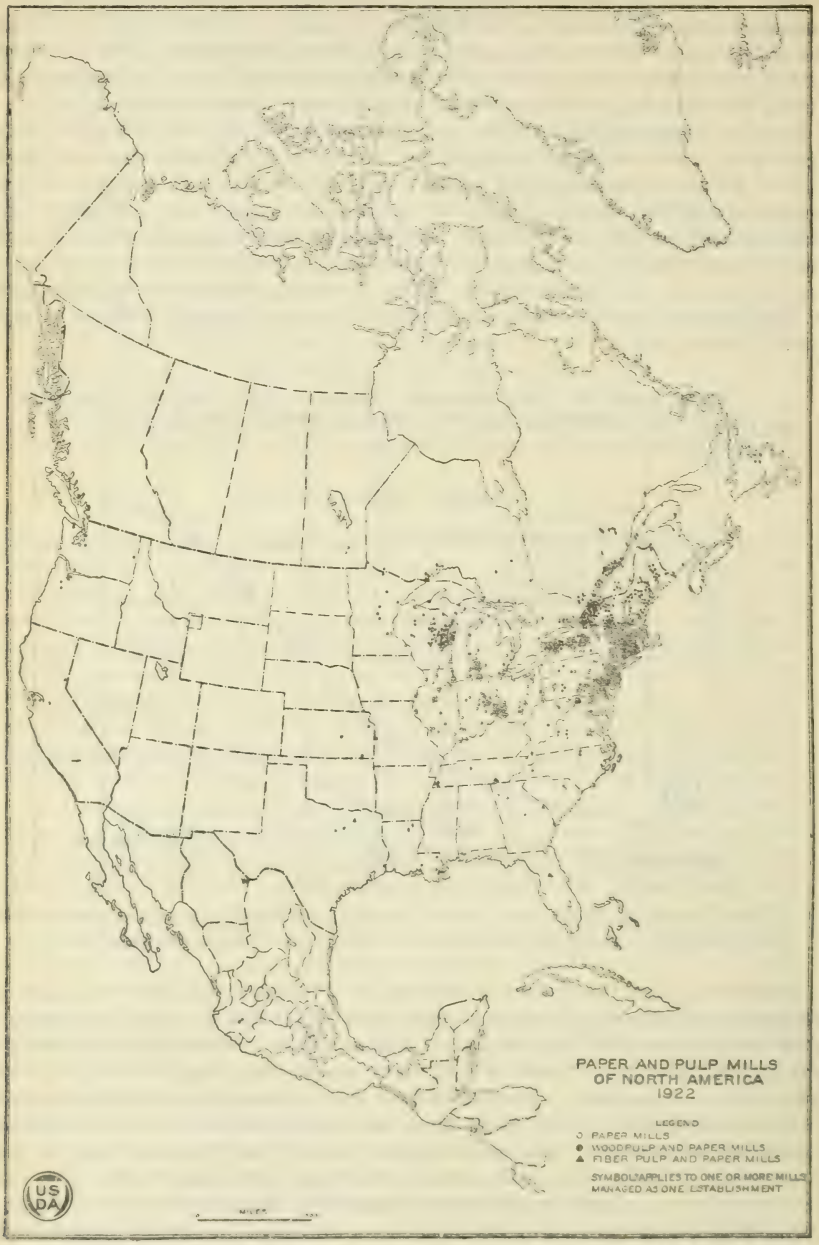


FIG. 3.—The pulp and paper mills of the United States are largely concentrated in the New England, Middle Atlantic, and Lake States, in and tributary to forests of spruce, fir, and hemlock. Few mills are located in Alaska, the Pacific coast, and Southern States, which have much larger pulp-timber resources.

its product from the aspen [3] in the spruce forests. The character and the extent of the centralization need not be discussed further here but are shown graphically in Figure 3 and numerically in Table 8.

This centralization, in fact overcentralization, intensifies the problem created by the imports from other countries of pulp wood, pulp, and paper, and it is the chief factor in the situation which necessitates pulp-wood imports. Analyses of imports from foreign countries both of raw pulp wood and of manufactured pulp and paper will be made in the following sections. A general explanation here, however, of the complex situation that exists in pulp wood, pulp, and paper imports and in the combinations in paper manufacture of pulps derived from wood and from other materials may clarify the facts.

We cut a large volume of domestic pulp wood, manufacture it into wood pulp, and then into paper. But we import a large amount of pulp wood each year from Canada, which is mixed with and follows the same course of manufacture as our own. We also import a large amount of wood pulp each year from Canada and several north-European countries. This imported pulp mingles with the product of home-grown timber and imported Canadian pulp wood in the manufacture of various so-called grades of paper in American mills. Still further, large aggregate paper imports from Canada and several European countries compete in the American markets with the product of American mills, which as previously indicated utilize both domestic and foreign raw materials.

The chief grades of paper only—book, wrapping, boards, and newsprint—are considered in detail in this report. The four grades of wood pulp, combined in different proportions, make up or help to make up these and other grades. A large and rapidly growing use of old paper of all kinds (85 per cent wood) mingles with new pulp in various papers. The manufacture of distinct pulps and papers from raw materials other than wood and the combination of wood and nonwood pulps complicate production still further. Linen rags from foreign and cotton rags from home sources are, for example, mixed with sulphite and soda pulp in various fine papers. Straw, on the other hand, entirely native, is used in the manufacture of a special class of boards. Imported manila stock goes into special kinds of manila paper. Finally, we export varying amounts of a number of pulps and papers. These involved relationships may be traced in Figure 4.

HOW PRESENT AND PAST REQUIREMENTS HAVE BEEN MET.[4]

Between 1869, the first year that wood-pulp production was reported, and 1922 the manufacture of paper in the United States increased 18 times while its consumption increased more than 20 times. American paper mills, in other words, were unable during this period to keep pace with the acceleration in consumption; imports of paper increased nearly 80 times in value and the difference between production and consumption has now reached about 1 million tons. But at the same time that American paper production was falling behind consumption American pulp mills, supplied though they were with imported as well as domestic wood, fell rapidly behind the demand of the paper mills, so that pulp imports, only a little more than 25,000 tons in 1889, had increased to more than 1¼ million tons in 1922. And finally, the pulp mills in turn have had to meet their growing

[3] Aspen is used throughout this report for the species commonly known in the pulp and paper industry as poplar.

[4] The data used in the analysis of our imports, outside of those available from census reports and Bureau of Foreign and Domestic Commerce reports of imports and exports, have been derived by use of such known relationships as that of cords in pulp wood to tons of pulp of the different grades and that of the average proportions of the different grades of pulp in various grades of paper. While the resulting figures are not absolutely accurate, both current relationships and trends up to the present time are shown concretely and it is believed closely enough for all practical purposes.

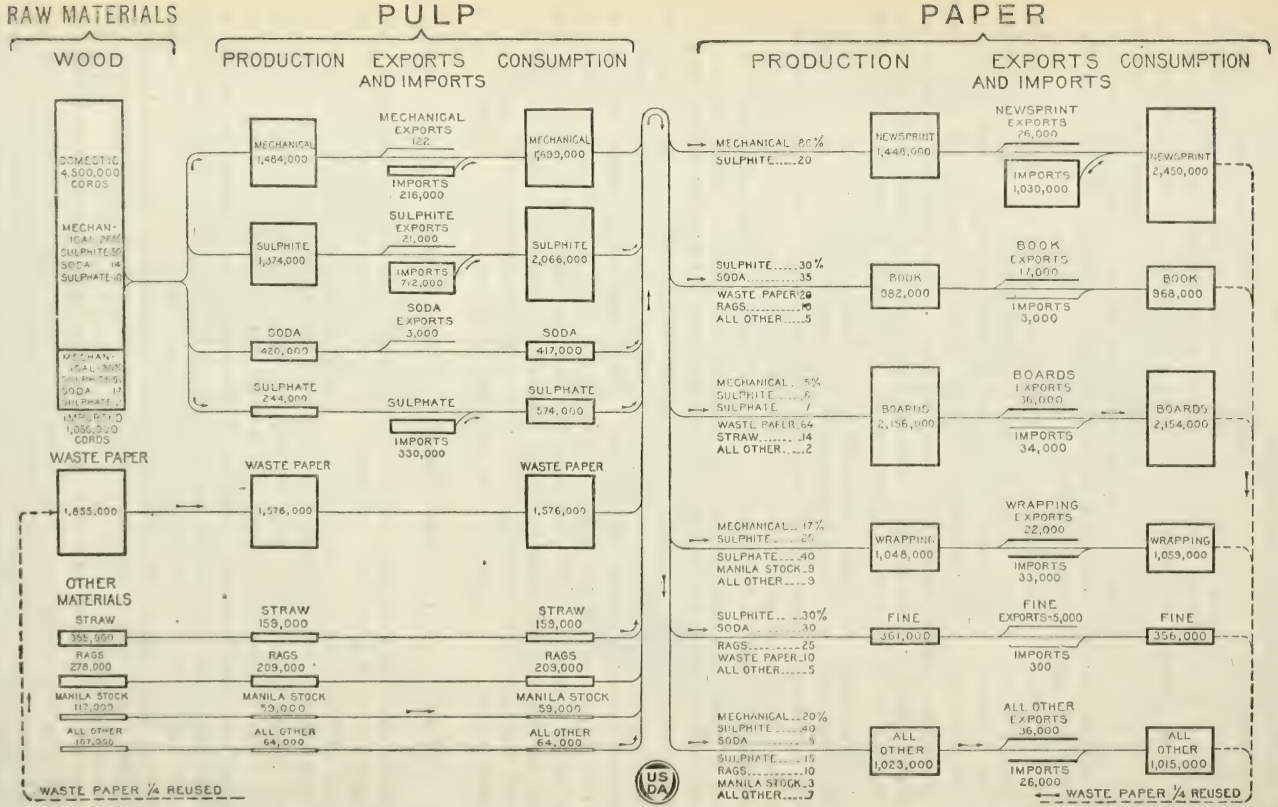


FIG. 4. **Amounts in tons, except for pulp wood.**—To permit comparison, pulp wood although stated in cords is plotted in tons The involved relationships between raw materials, pulp, and paper are further complicated by imports and exports. The rectangles followed horizontally show, with the connecting lines, the course from raw material to final product, while followed vertically the rectangles show the comparative volume of various raw, intermediate, and final products. The data on pulp wood and its products are for 1922, and that for other materials and their products are for the closely similar year of 1919.

volume of pulp-wood requirements partly through pulp-wood imports, which probably began as early as 1895, and since 1912 have ordinarily exceeded 1 million cords a year

Stated in another way, our paper industry in 1922, manufactured more than 7 million tons of paper from domestic and foreign supplies, but we consumed 8 million tons. Our pulp industry manufactured $3\frac{1}{2}$ million tons of pulp, in part from imported wood, but 5,847,000 tons were required for our total paper consumption. Finally, we cut from American forests $4\frac{1}{2}$ million cords of wood, but the total consumed in the United States and elsewhere to meet our paper requirements was 9,148,000 cords of domestic and foreign wood. Only 88 per cent of the paper consumed in 1922, was manufactured in the United States; only 60 per cent of the pulp used in making the paper consumed was a home product; and only 49 per cent of the wood used in meeting paper requirements

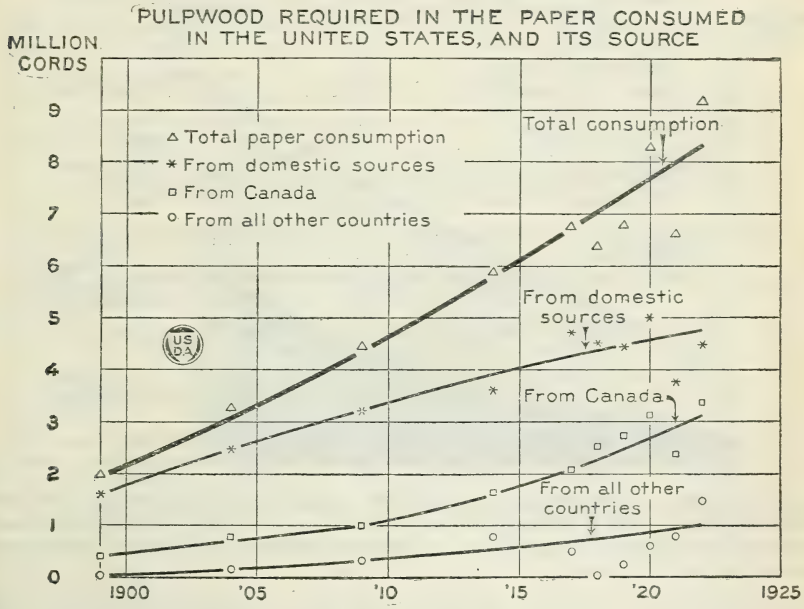


FIG. 5.—The gradual parting of the curves representing total pulp-wood requirements and the pulp wood secured from domestic sources shows strikingly the growing volume of imports. The contribution of the Canadian forests supplied in the form of paper, pulp, and pulp wood is increasing more rapidly than that of our own.

came from our own forests. These figures indicate specifically the extent to which American paper mills, pulp mills, and forests, respectively, now fall short of meeting national needs for paper.

Hardly less important than the extent of our present imports from foreign sources is the rate at which they are increasing. As recently as 1899, little more than two decades ago, American forests furnished 83 per cent of the wood for our paper. (Table 10.) Imports have since been increasing at the rate of about 192,000 cords a year. The outstanding fact to-day is that more than half of the forest materials for all the paper used in the United States comes from outside our boundaries. The curve in Figure 5 which indicates domestic pulp wood has been gradually flattening since 1905, while those indicating all pulp wood, pulp, and paper imports from Canada and from other countries converted to pulp wood, for comparison are still rising rapidly. The growth, present extent,

and character of the dependence of the United States for the wood required in our paper is further shown in Figure 6, while the part of total requirements secured from domestic and foreign sources is shown in Tables 10, 11, and 12.

This general background affords a better basis for the consideration of pulp-wood imports.

PULP WOOD.

It took 9,148,000 cords of wood to supply our 1922 paper requirements, of which about 4,498,000 cords were cut from our own forests. We exported an equivalent of 235,000 cords. Pulp-wood imports amounted to nearly 1,045,000 cords (Table 34) and hence furnished 11 per cent of all the wood required and 19 per cent of all the pulp wood consumed in American mills. The remainder of our requirements, equivalent to 3,840,000 cords, was imported as pulp and paper.

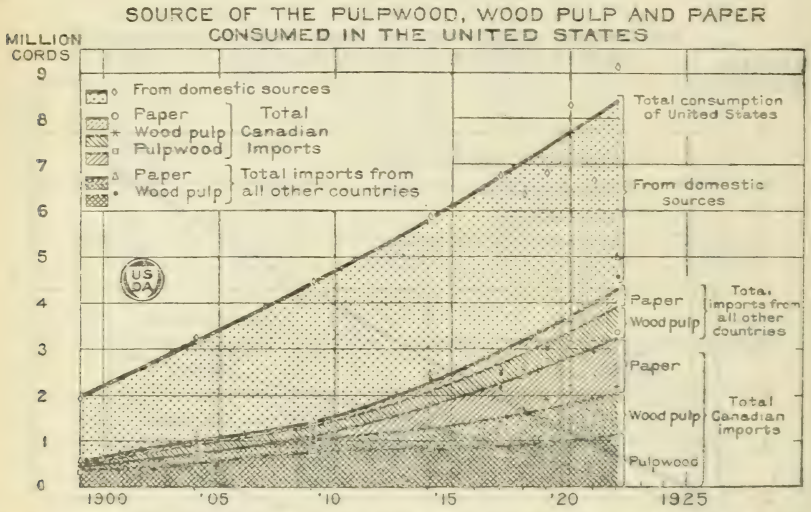


FIG. 6.—Increasing imports, particularly since 1909, have consisted almost entirely of pulp and paper. These products are being manufactured in other countries near the forests on which they depend. Total Canadian imports are nearly as large as the contribution from American forests. The data are shown in cumulative curves.

We import pulp wood from Canada alone, since it is the only country with suitable timber supplies near enough to make the payment of the freight costs economical. Pulp-wood importations began about 1895 in significant quantities and increased until about 1910, when they slightly exceeded 930,000 cords. Since that date there has been relatively little change. It was on May 1, 1910, that the pulp-wood embargo upon the Crown lands of Quebec, the Canadian Province best situated for importations to the United States, became effective.

The growth of pulp-wood imports corresponds roughly with the first part of the period during which the American industry was expanding with greatest rapidity. Imports began when American manufacturers were able to secure Canadian timber more easily than American, and when they began to realize the limitations in their own holdings and in American resources of their own regions.

Canadian imports consist chiefly of spruce with a certain amount of fir, which together make 83 per cent of the total pulp-wood imports and which go largely into sulphite and mechanical pulp. The remainder, 17 per cent, is aspen (Table 5) and constitutes practically the entire Canadian cut. It goes largely into soda pulp.

WOOD-PULP GRADES.

The slowing down in pulp-wood imports naturally affects wood-pulp imports. The latter began in volume about 1900. While they increased gradually prior to 1910, their subsequent growth has been more rapid. Present and past requirements of the various grades of wood pulp and of the amounts of pulp wood necessary for each, on which the following detailed analysis is based in part, are shown in Tables 13 and 14 and Figure 7. Consideration is not confined to the imports of pulp as such, for it is equally important to learn what our dependence is for each class of pulp, whether importations take the form of pulp wood, pulp, or paper.

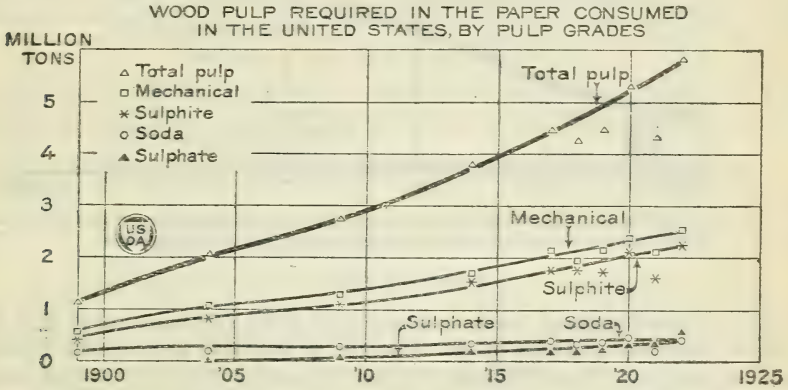


FIG. 7.—Requirements for mechanical and sulphite pulp are much larger and are increasing much more rapidly than for soda and sulphate pulp.

SODA PULP.

Although pulp-wood requirements for soda pulp have more than tripled since 1899, they now constitute only about 759,000 cords (Table 15), or 8 per cent of the total needed each year for our entire paper requirements. Despite the fact that soda was the first wood-pulp process introduced into the United States, it has grown so slowly in comparison with other grades and absorbed so little wood that more than 600,000 cords, or 80 per cent of our total requirements, are secured from domestic pulp wood. A large number of hardwood species are suitable and they occur over an extended territory, in part remote from the Canadian border, so that relatively ample timber supplies are still available. Furthermore, many soda mills were located in rag-pulp centers before wood pulp reached its present importance, near most of which relatively large amounts of suitable hardwoods of a quality too low for use in most other industries are still available. It is not surprising, therefore, that the United States is more nearly self-supporting in the wood utilized in the manufacture of its soda than any other wood-pulp grade.

Aspen pulp wood from Canada is the chief item in imports of soda-pulp material. Nearly 180,000 cords were imported in 1922. (Table 5.) This was 99 per cent of the soda-pulp material which Canada furnished for that year, and Canada supplied approximately 92 per cent of our total importations. Since 1899 Canada's contribution, chiefly pulp wood for the entire period, has increased nine times. Pulp-wood imports amount, therefore, to about 92 per cent of 1922 imports of soda-pulp material in all forms, but, as will be shown later, it should be comparatively easy to secure an equal and even a much larger volume of soda-pulp woods from our own forests.

Imports of soda pulp, and of book paper, of which it is an important constituent, from both Canada and Europe are negligible. The United States exports offset imports in all forms by about one-fifth. The general trend of requirements and of the relative amounts of the raw materials secured from domestic and foreign sources is shown in Figure 8 and Table 16.

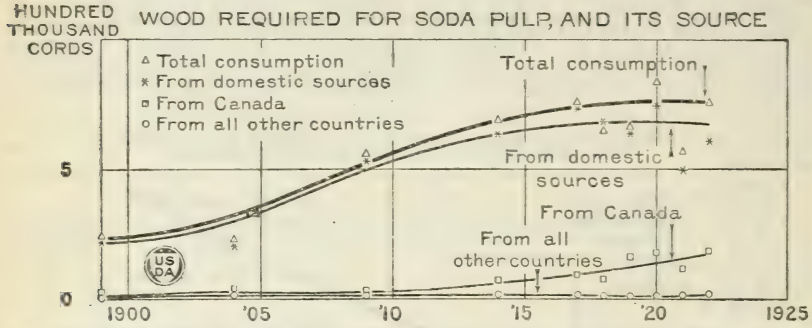


FIG. 8.—The United States is more independent of foreign sources for soda pulp than for any other kind. Eighty per cent o fthe pulp wood required is secured from American forests.

SULPHATE PULP.

About 1,220,000 cords of wood, or 14 per cent of the requirements of 1922 for all paper, went into sulphate pulp. The use of sulphate pulp in the United States began as recently as 1904, and the first domestic production was four years later.

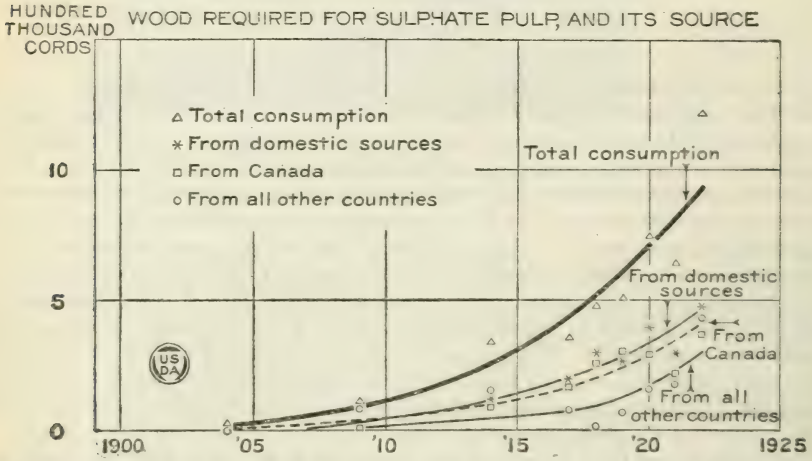


FIG. 9.—Sulphate pulp was first used in the United States about 1904, and production in this country began four years later. Total pulp-wood requirements are now more than a million cords, 83 per cent of which comes from other countries.

The imports of pulp wood for sulphate pulp are very small, amounting to less than 2,000 cords in 1922. Imports of wrapping paper are also small, aggregating in 1922 a little less than 33,000 tons, half from Sweden and the remainder from a number of countries. With small amounts of both pulp wood and paper, it follows that imports must consist largely of wood pulp. Pulp, in fact, aggregated in 1922 more than 330,000 tons (Table 31) out of a

total dependence of 376,000 tons (Table 18). This is the only grade of wood pulp in which we are more dependent on Europe than on Canada. European countries, chiefly Sweden, Finland, Norway, and Germany, furnished in 1922 an equivalent of 35 per cent of our requirements in pulp wood. American forests furnished 41 per cent, and Canada 28 per cent.[5] (Table 17.) Exports were small.

Our relative dependence upon foreign countries in 1922 for sulphate imports in pulp form was as follows: Canada, 46 per cent; Sweden, 42 per cent; Finland, 8 per cent. Only these countries made shipments of importance.

A complete shutting off of pulp-wood imports would therefore affect only about 2,000 cords of wood used for sulphate pulp, on the basis of 1922 data. The general trend of requirements and the relative amounts of raw material from domestic and foreign sources are further shown in Figure 9 and Table 18.

SULPHITE PULP.

While half of the wood needed for paper in 1922 went into sulphite, the pulp tonnage of 2,278,000 falls below mechanical because of lower yields secured by

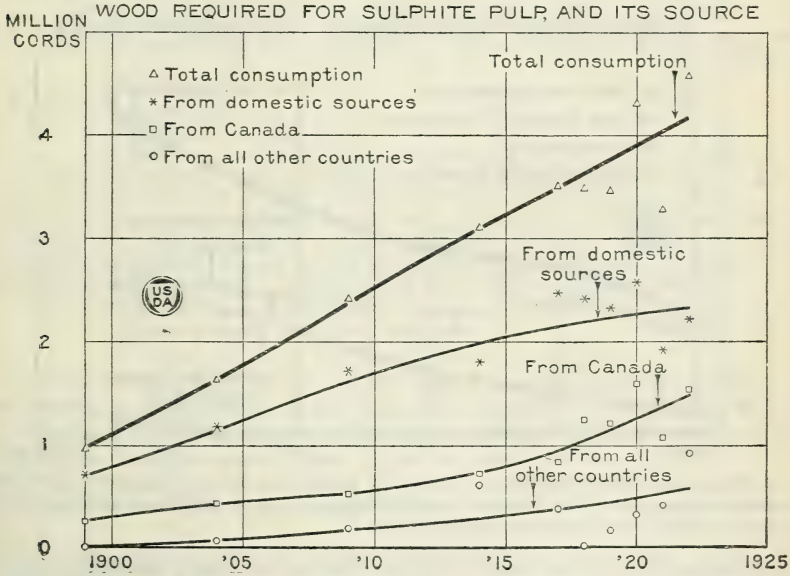


FIG. 10.—More than half of the pulp wood necessary for the sulphite pulp utilized in meeting American paper consumption is of foreign origin. Imports are greater than of any other kind of pulp and are increasing by an equivalent of nearly 100,000 cords a year.

the chemical process. Wood requirements for sulphite have increased nearly five times since 1899, and by more than 3½ million cords. (Table 19.)

Native forests supplied only 48 per cent of the pulp wood needed for sulphite in 1922. This is in striking contrast with 1899, when these forests furnished 75 per cent. Our largest imports are from Canada, which in 1922 shipped as pulp wood, pulp, and paper the equivalent of more than 1½ million cords of pulp wood, approximately one-third of total requirements and 63 per cent of imports. Exports were small.

Unlike either soda or sulphate, a large volume of the sulphite pulp consumed is imported in paper. Approximately 1,030,000 tons of newsprint paper, con-

[5] The percentages in this and similar cases are percentages of consumption and total more than 100 because some paper is exported.

taining about 20 per cent of sulphite pulp, were imported in 1922. Of this paper Canada supplied 87 per cent. The total volume of sulphite imported in paper of other kinds is too small for comment.

Sulphite imports as pulp were considerably larger than in paper, aggregating slightly over 710,000 tons in 1922. (Table 32.) Of this, Canada supplied 42 per cent, Sweden 37, Norway 11, and other countries small amounts. Reduced to pulp wood, the pulp imports would therefore represent about 1,560,000 cords.

Five hundred and fifty thousand cords of the pulp-wood imports from Canada were used for sulphite pulp. This figure, which is larger than for any other pulp grade, measures the volume which we must secure from our own forests in order to be self-supporting in sulphite pulp wood. The sulphite-pulp relationships described are further shown graphically in Figure 10 and Table 20.

MECHANICAL PULP.

Mechanical pulp made up slightly over 2,580,000 tons of American pulp requirements in 1922, or 44 per cent, and constituted the largest pulp grade.

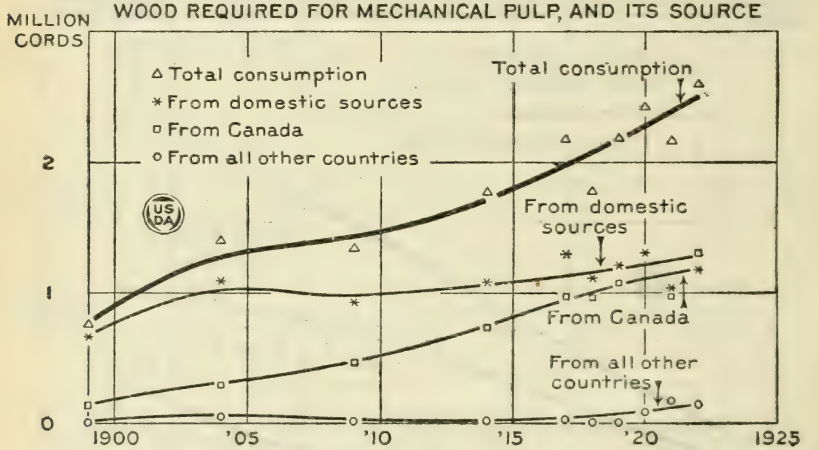


FIG. 11.—The amount of domestic pulp wood reduced by mechanical process has remained at practically the same level since 1904. The increased quantities necessary to meet American requirements have been imported chiefly from Canada in newsprint paper.

Since, however the yield per cord by the mechanical process is relatively high in terms of pulp wood, the 1922 requirements for mechanical pulp were slightly less than 2,600,000 cords, or only 28 per cent of the total.

Pulp-wood requirements for mechanical-pulp needs have become more than three times those of 1899, and the pulp-wood equivalent of imports in all forms has been multiplied by ten. Domestic pulp wood now supplies only 45 per cent of our mechanical pulp-wood requirements, and its contribution has increased but little in the last 20 years. Canada now furnishes 89 per cent of the imports, with the equivalent of nearly 1,300,000 cords of pulp wood. (Table 21.)

Transportation difficulties confine the small importations in pulp form almost entirely to near-by Canada (Table 33), and from there an equivalent of about 190,000 tons in 1922, or an equal number of cords, maintains a level which has held substantially since 1909 and 1910.

Newsprint paper imports of nearly 1,030,000 tons in 1922, 80 per cent of which is mechanical pulp, represent a pulp-wood equivalent of more than 900,000

cords. Eighty-seven per cent of this was supplied from Canada. Pulp-board imports in 1922 were less than 31,000 tons, and only about one-fifth of its material was new pulp, of which mechanical pulp formed only one-fourth.

Approximately 318,000 cords of the total pulp-wood imports from Canada in 1922 were utilized for the manufacture of mechanical pulp. The volume is second only to pulp-wood imports for sulphite pulp. The mechanical-pulp situation of the past 20 years is further shown in Figure 11 and Table 22.

Some of the preceding relationships between domestic pulp-wood supplies and imports in pulp wood, pulp, and paper form are summarized graphically in Figure 12 for all four pulp grades.

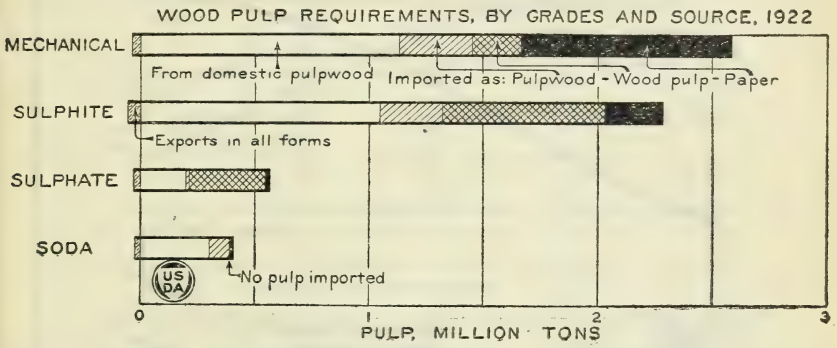


FIG. 12.—Domestic pulp wood supplies less than half the requirements for all of the mechanical, sulphite, and sulphate pulp consumed. It furnishes 80 per cent of the requirements for soda pulp. The greater part of the mechanical pulp secured from foreign sources is imported as paper. The greater part of sulphite and sulphate imports are in pulp form, while those of soda are in pulp-wood form.

PAPER GRADES.

The different grades of paper contain chiefly varying proportions of two or more grades of wood pulp. Accordingly the discussion of the source of pulp requirements forms a logical preparation for considering the source of the grades of paper, the final product to which they contribute.

BOOK PAPER.

Book paper is made on the average of about 40 per cent soda[6] and 35 per cent sulphite pulp.[6] Old book paper, rag stock, and limited quantities of other materials supply the remaining 35 per cent. Thus only about 725,000 tons of the total book-paper consumption in 1922 represented new wood-pulp requirements (Table 23).

The United States supplies from home-grown wood about 58 per cent of this new pulp. We depend upon Canada for 31 per cent and upon various European countries for 13 per cent. Exports of book paper are small.

The largest factor in our imports, totaling 27 per cent, and that which is growing most rapidly, is pulp, almost entirely sulphite, and a little more than half Canadian in its origin. It is equivalent to about 380,000 cords of the spruce-fir-hemlock group of pulp woods. Canadian pulp wood makes up about 17 per cent of our consumption, with approximately 130,000 cords of aspen for soda pulp and 140,000 cords of spruce and fir for sulphite. Book-paper imports are negligible.

The forests of the United States furnished 30 per cent less of the new wood materials for book paper in 1922 than in 1914. What is still more serious, the

[6] These average percentages differ slightly from those for a single year in Figure 4.

amount of American wood supplied fell off actually by about 185,000 cords as well as relatively, a disquieting situation which is brought out sharply in Figure 13.

The most urgent phase of the book paper problem on the basis of 1922 requirements is, therefore, to secure from our own forests each year additional amounts of about 130,000 cords of aspen for soda pulp and 140,000 cords of spruce for sulphite pulp and thus become independent of pulp-wood imports.

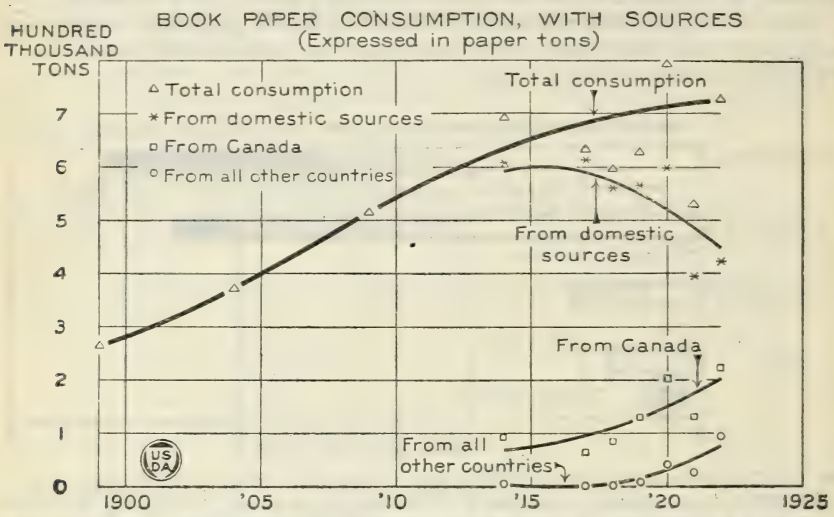


FIG. 13.—The amount of domestic wood used in the manufacture of book paper has fallen off rapidly since 1914, but this decrease has been made up and more by imports of pulp wood, pulp, and paper from other countries.

WRAPPING PAPER.

Wrapping paper averages in its composition about 40 per cent of sulphate pulp, 25 per cent of sulphite, 17 per cent of mechanical, 9 per cent of manila stock, and the remainder of other materials.

The United States is more nearly self-supporting in materials for wrapping than for any other class of paper, with 66 per cent of requirements coming from American forests in 1922. (Table 25.) Dependence for the remainder is divided about equally between Canada and Europe. Exports are small.

As in book paper, material for wrapping is imported mostly as pulp, a total of about 27 per cent, in approximately equal amounts from Canada and Europe. Paper imports are small and from Europe, while Canada supplies all the pulp wood, amounting only to 6 per cent, or about 130,000 cords of spruce and fir.

As in book paper, the United States has been increasing the volume of its imports. In the eight years following 1914 the use of American material declined 21 per cent, and, moreover, the actual amount declined about 140,000 cords. The trend is illustrated graphically in Figure 14.

BOARDS.

Although the total American "boards" consumption for 1922 falls short of newsprint consumption by only a relatively small amount, some 80 per cent of boards consists of all sorts of waste paper and straw. The 20 per cent of new pulp which normally goes into board manufacture meant, therefore, in 1922 about 430,000 tons in manufactured paper. (Table 24.) Sulphite, sulphate, and mechanical pulp each contributes about one-third to this new material.

Sixty-one per cent of the new pulp material was secured from American forests. We imported 26 per cent from Canada and about 15 per cent from Europe. Exports offset imports by only 2 per cent. As in both book and wrapping paper, pulp is the outstanding factor of the imports, totaling 27 per cent. Pulp

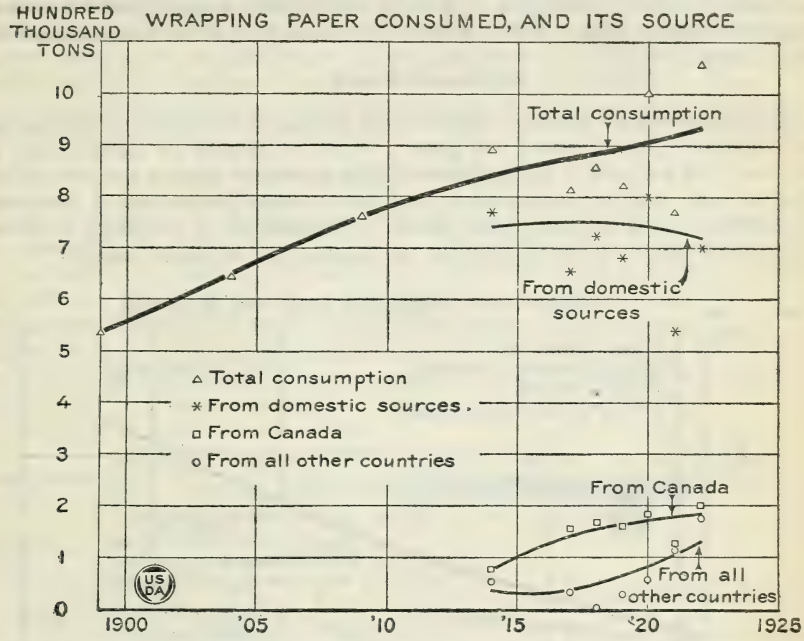


FIG. 14.—American materials used in producing wrapping-paper requirements show a slight downward tendency. Increased consumption, however, is being met by foreign supplies. Imports of wrapping paper or its materials are less than of any other paper grade

imports alone are expanding appreciably. There is a relatively small import of manufactured boards and a still smaller volume of pulp wood, only 6 per cent, and all from Canada. The 27,000-cord spruce and fir pulp-wood import is manufactured into mechanical sulphite and sulphate pulp.

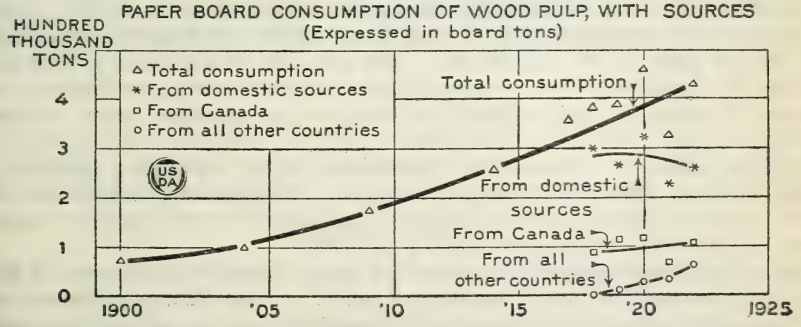


FIG. 15.—The amount of domestic pulp wood used in boards seems to be falling off slightly, but board consumption is still increasing very rapidly.

Our total dependence, as in the case of both book and wrapping paper, has increased both relatively and actually. In four years the contribution of American forests to board manufacture fell off approximately 80,000 cords. Figure 15 shows the decline.

Wood supplies 85 per cent of the raw materials which make up the waste paper contribution to board manufacture. For these wood materials we import from foreign countries the amounts indicated in the preceding and following discussion for the various pulps and papers. Our total dependence on foreign countries for raw board material is, therefore, in a sense considerably greater than the volume indicated for new pulp. Reuse, however, reduces the annual requirements for new material.

NEWSPRINT PAPER.

Eighty and twenty per cent represent the average contribution of mechanical and sulphite pulps to newsprint paper. Since we import as paper, pulp, or pulp wood 56 per cent of the mechanical pulp consumed and 54 per cent of the sulphite pulp, it is not surprising to find that a larger percentage of newsprint is imported than of any other paper grade. Consumption of newsprint in excess of any other paper grade emphasizes the significance of larger imports.

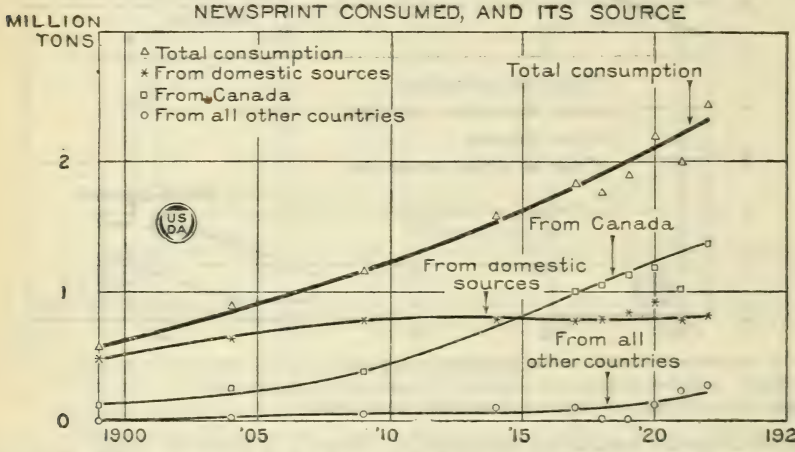


FIG. 16.—The United States is more dependent upon outside sources for its newsprint than for any other grade of paper. Since 1904 Canadian imports in pulp wood, pulp, and paper have met nearly all increased American demands, until now we draw more heavily upon Canadian forests than our own.

In 1899, little more than two decades ago, 83 per cent of the wood from which newsprint was manufactured came from home forests, but this percentage had in 1922 dropped to 34. (Table 26.) The only relieving feature is that the falling off of materials from American sources is relative only, not actual; the amount of domestic wood utilized for newsprint has increased about 450,000 cords.

Canada makes the outstanding contribution to our newsprint supplies, a total of 56 per cent of the amount consumed, or considerably more than the contribution of American forests, while all European countries together supply only 11 per cent. We export barely 1 per cent.

By far the largest imports are newsprint paper, a total of 42 per cent of the amount consumed, all but 5 per cent of which is from Canada. Canada, in fact, exported to the United States in 1922 nearly 83 per cent of its entire newsprint production. Imports of Canadian newsprint alone in 1922 exceeded the production from American wood, and this in spite of the fact that as recently as 1909 they totaled only 20,000 tons.

Pulp makes an additional contribution of 14 per cent, slightly more than half of which comes from Canada. Increase in pulp imports has been much

less than in newsprint paper, totaling for both Canada and Europe less than an equivalent of 325,000 tons of paper since 1899.

While total requirements have been growing at the rate of 82,000 cords a year since 1899, imports have been growing at the rate of 66,000 cords. Total imports in all forms, paper, pulp, and pulp wood, from all countries are equivalent to about 2,050,000 cords. Of this, 350,000 cords comes from Canada in pulp-wood form—more than for any other paper grade. An additional 1,375,000 cords comes from Canada in the form of wood pulp or newsprint. Figure 16 shows more strikingly than discussion the trend of the imports in comparison with the use of domestic pulp wood.

OTHER KINDS OF PAPER.

It is unnecessary for the purposes of this report to make similar analyses of our dependence for other kinds of paper. The amounts involved for any one class are relatively small, even though the totals for all kinds may be important. Furthermore, the complications encountered in such analyses are such as to make them extremely difficult and unsatisfactory.

Some of the preceding relationships between domestic pulp-wood supplies and imports in pulp wood, pulp, and paper form are summarized graphically in Figure 17 for newsprint, wrapping paper, book paper, and boards.

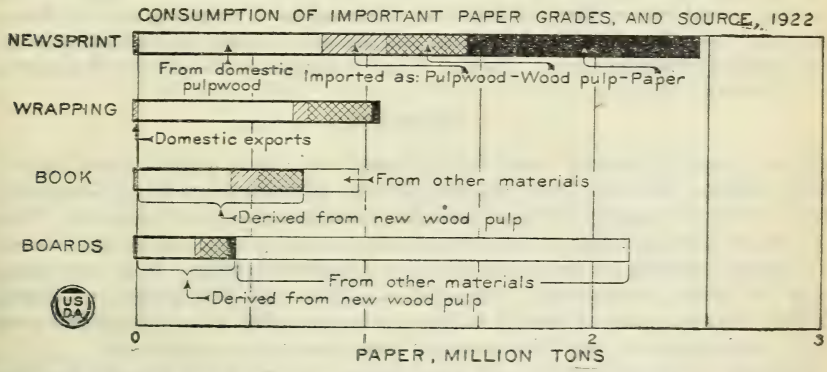


FIG. 17.—Only about one-third of the pulp wood required for newsprint paper is obtained from domestic sources. While imports of pulp and pulp wood are large, paper is by far the largest factor in newsprint imports. Two-thirds of the wrapping paper consumed is derived from domestic pulp wood, and pulp is the largest factor in the imports. Pulp is the largest factor in imports for both boards and book paper.

COUNTRIES.

Any analysis of our imports would be incomplete without a recapitulation by countries. Those of Europe form a logical group and are treated together. The discussion of Canada includes Newfoundland and Labrador.

EUROPEAN COUNTRIES.

Pulp and paper are imported from a number of European countries, but only Sweden, Norway, Finland, and Germany, in about the order named, are of particular importance. Imports from non-European countries other than Canada are so small that they are incorporated without materially influencing the totals. Altogether Europe in 1922 supplied an equivalent of approximately 1½ million cords of pulp wood (Table 27) or 17 per cent of the total of 9,148,000 cords needed for the entire paper requirements of the United States. Fully 96 per cent of these imports came from the countries named.

Because of distance and high freights, no pulp wood is imported from Europe, and only about 19 per cent of total imports in all forms comes as paper. It follows that the great bulk of imports from Europe, 81 per cent, are pulp.

Book paper is secured only in relatively small amounts. The tonnage of wrapping imports is considerably larger, a total of about 33,000 tons, and one-half is from Sweden. Among the papers newsprint moves to the United States in largest volume, totaling for 1922 about 135,000 tons and ranging downward from a little over 50,000 tons from Sweden to lesser amounts from Germany, Finland, and Norway, and to very small shipments from other countries. (Table 38.)

The pulp-wood equivalent of pulp shipments reaches nearly 1,225,000 cords, 67 per cent of which is sulphite, 29 per cent sulphate, and only 4 per cent mechanical. Sweden is as far in the lead in pulp shipments as in paper, with approximately 68 per cent of the total, and Norway is second with 15 per cent. Additional data showing the sources of European pulp and paper shipments to the United States in 1922 are not of sufficient importance to warrant discussion but are shown in Table 40.

Imports have made up quickly the serious interruption occasioned by the World War. The pulp-wood equivalent of approximately 38,000 cords in 1899 from all European countries had increased fortyfold by 1922. The sulphite and mechanical pulp and the newsprint imports are derived from the spruce group of pulp-wood species, and in 1922 were equivalent to about 1 million cords of wood, or two-thirds of the total imports. Shipments of wrapping and sulphate, which can be secured from pine, were, on the other hand, equivalent to only approximately 500,000 cords. Figures 5 and 6 illustrate the growth of imports from European counties.

CANADA.

Annual imports of pulp wood from Canada now total a little more than 1 million cords. But our total imports derived from the forests of Canada in 1922 were in the neighborhood of 3,374,000 cords, as shown by Table 28. This is 37 per cent of our total requirements, and is only 12 per cent below the volume of material supplied to American users by American forests. It is more than twice the volume furnished by all other countries. It is a growth of about 128,000 cords per year, or nearly 3 million cords since 1899, when the 420,000 cord import equivalent was only 22 per cent of total American requirements.

Although when reduced to pulp wood, paper imports from Canada in 1922 exceeded pulp, and pulp in turn exceeded pulp wood, the spread between the high and low barely exceeded 150,000 cords. There has been relatively little increase in pulp-wood imports since 1909. But wood-pulp imports during the same period have increased approximately 4 times, while the tonnage of paper is larger by nearly 55 times. The relative rates of increase of pulp wood, pulp, and paper imports for Canada are further shown in Figure 18.

More in detail, pulp-wood shipments now range somewhat above 1 million cords, of which 83 per cent is of spruce and fir and the remainder of aspen. The pulp imports include a little over 300,000 tons of sulphite, a little over 190,000 tons of mechanical, and 154,000 tons of sulphate pulp. These quantities represent, respectively, about 13 per cent, 7 per cent, and 26 per cent of our total consumption of each grade. Book-paper imports are negligible. Boards total less than 30,000 tons, while newsprint aggregates more than 895,000 tons, 37 per cent of our requirements for this paper, and about 70,000 tons more than we produce in the United States from American wood.

Altogether imports in 1922 of pulp wood, pulp, and paper derived from spruce and fir represented 2,850,000 cords, of which, as already indicated, 870,000 cords were in pulp-wood form. Total imports derived from aspen, the raw material for soda pulp, amounted to 196,000 cords, and 92 per cent of this entered the country in pulp-wood form. Imports from Canada are further shown in Figures 5 and 6.

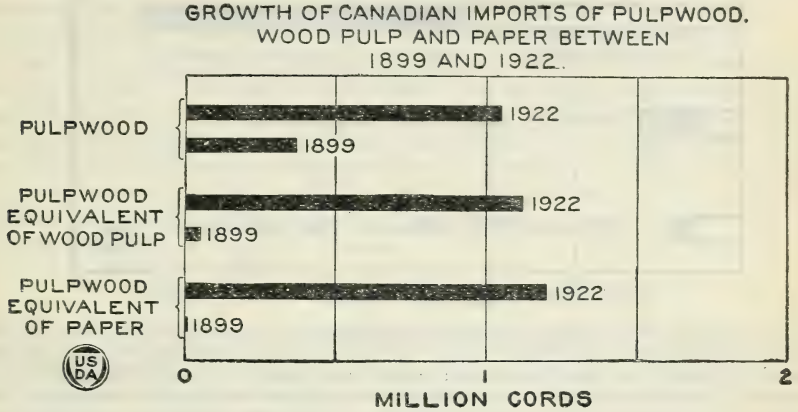


FIG. 18.—The United States depended on Canada about equally for pulp wood, wood pulp, and paper in 1922. As late as 1909 pulp wood constituted our only import of note. Pulp and paper imports are now growing by leaps and bounds, while pulp-wood imports are practically at a standstill.

SPECIES AND GROUPS OF SPECIES.

The foregoing analysis of the contribution of domestic supplies and imports to our requirements has proceeded from pulp wood through the various grades of pulp and paper to the countries from which the imports have been secured. There remains the need for a summation of our total pulp and paper requirements and imports in terms of cords of the species or groups of species of the woods utilized for each pulp grade. Such a summation will make it possible to relate the entire question of requirements and imports back to the forests, its fundamental source. It is indispensable in pointing out the forest regions of the United States which afford the most favorable conditions for the increased cut needed to offset both pulp-wood and total imports.

For our entire sulphate consumption we needed about 1,220,000 cords of wood in 1922. Spruce, fir, and hemlock have been used to a greater or less extent for sulphate pulp, but the hard pines and larches make a pulp which is entirely satisfactory for most purposes. It would require only about 2,000 cords of jack, southern, and western pine to meet current pulp-wood imports for sulphate pulp. Entire independence would on the basis of 1922 consumption require 773,000 cords of these pines in addition to what we now cut, with an increase hereafter of 110,000 cords a year, the rate at which requirements have been growing since 1914.

So far soda pulp alone accepts such hardwood species as aspen, basswood, the southern gums, yellow poplar, soft maple, and others of similar pulping properties. In all the paper consumed the requirements for soda pulp in 1922 were only 759,000 cords. For soda pulp, entire independence and the absorption of pulp-wood imports are little different. The former would take, on a 1922 basis, 196,000 cords of any one or more of a number of hardwoods, with a subsequent increase of only about 23,000 cords a year, the rate of increase since 1899.

The spruce-fir-hemlock group of softwood species are now used almost exclusively for both mechanical and sulphite pulp. The use of jack pine for

sulphite pulp is still in its infancy. Mechanical and sulphite pulp together (Table 14) absorbed nearly 7,170,000[7] cords, or 78 per cent of the total pulp-wood requirements for 1922. Our pulp-wood requirements for these two pulp grades

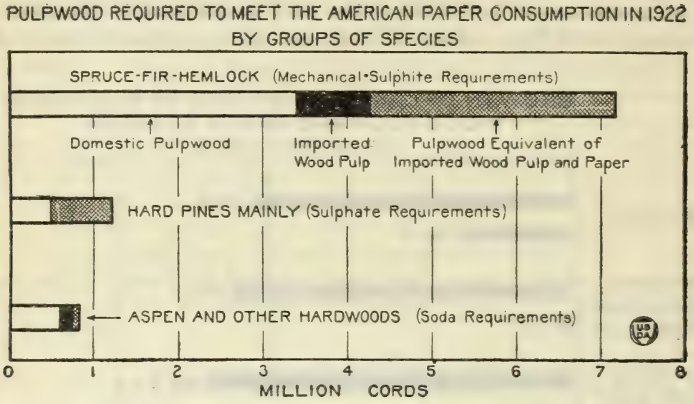


FIG. 19.—Pulp wood for mechanical and sulphite pulp constituted 78 per cent of the total required in the paper consumed in the United States in 1922. Use is confined almost exclusively to spruce, fir, and hemlock, of which there remain only limited supplies in the regions where the pulp industry is concentrated. Much smaller amounts of pine and hardwoods are needed for sulphate and soda pulp. The outstanding problem is, therefore, to secure additional domestic supplies of spruce, fir, and hemlock.

have increased at the rate of 237,000 cords a year since 1899 against a rate of about 313,000 cords a year (Table 29) for our total pulp-wood requirements. The great need under present pulp and paper processes is therefore for spruce, fir, and hemlock. To offset pulp-wood imports, it will be necessary to find about

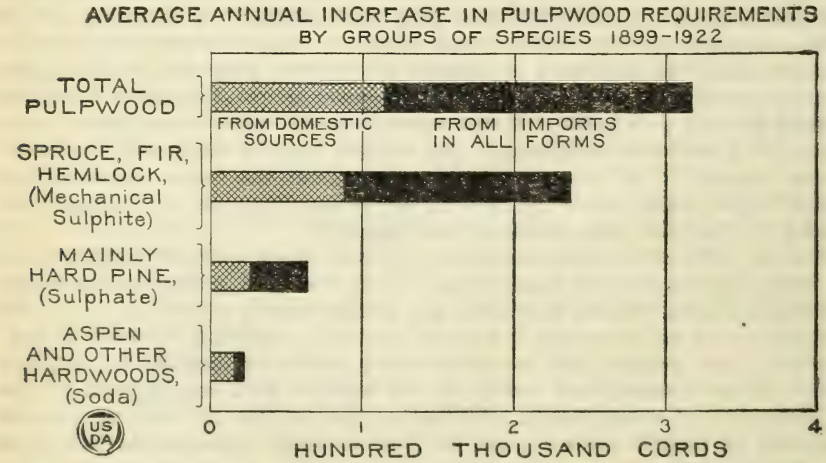


FIG. 20.—Seventy-five per cent of the average annual increase in pulp-wood requirements since 1899 has been for spruce, fir, and hemlock for mechanical and sulphite pulp. Except in hardwoods, imports of paper, pulp, and pulp wood combined have increased more rapidly than the cut of domestic wood.

870,000 cords. To be entirely self-supporting this amount would have to be increased to 3,916,000 cords, and it would be necessary to supplement the latter by an additional 237,000 cords a year to remain independent.

[7] This does not include the spruce, fir, and hemlock used in the sulphate process, but the omission is partly offset by the volume of species primarily suited for sulphate pulp which are used for mechanical and sulphite.

In the briefest possible terms, the urgent problem of the immediate future is to find 870,000 cords of spruce, fir, and hemlock and 180,000 cords of aspen or other hardwoods to offset pulp-wood imports.

An important but less urgent problem of the future is to secure from our own forests sufficient additional pulp wood to cover current imports of pulp and paper and to become entirely self-supporting in pulp-wood supplies. This can be accomplished by adding a total of 3,916,000 cords to the spruce-fir-hemlock cut, 773,000 cords to the pine cut, and 196,000 cords to the hardwood cut.

A third important future problem is to provide the pulp wood necessary to meet the increase in our paper requirements. This on the basis of the past decade or two would mean an annually enlarged cut of 237,000 cords of spruce, fir, and hemlock, 110,000 cords of pine, and 23,000 cords of hardwoods. The formulation of plans for future pulp-wood supplies requires a more detailed consideration, however, and this is given in the following section.

Figures 19 and 20 represent these problems graphically, and Table 29 shows additional details unnecessary to discuss.

PROBABLE FUTURE REQUIREMENTS.

Plans to furnish pulp-wood timber in the future must rest upon probable future requirements for paper and upon the part of the requirements which are likely to depend upon wood as the raw material and the part which will come from other raw materials.

PROBABLE FUTURE PAPER REQUIREMENTS.

Any forecast of paper requirements must be more or less speculative. Regardless of the obvious objections, however, some basis of this character is essential as a starting point in plans for supplying the necessary raw material. One of the methods which may be followed as a basis for a sane forecast is an extension into the future of the trends of the immediate past. A consideration of all grades of paper together is more likely to be correct than of each grade separately because of compensation of possible changes affecting individual grades. A curve indicating trends in paper consumption since 1810 is extended as far as 1950 in Figure 21, with some allowance for a decreased rate of increase over that of the immediate past. Available grade consumption data are also shown.

The enormous present consumption of paper makes it difficult to accept consumption in 1950 as great as 13½ million tons, the volume indicated in the curve. But a similar question might have been raised with justice in 1909, when requirements were greater than those of any previous year and when a prediction of the doubling of consumption by 1922 would have seemed rash indeed. The total had, however, nearly doubled in 13 years and in some grades had nearly trebled. The doubling of consumption in the past 13 years and quadrupling since 1899 makes less incredible an assumption that it may possibly double again during the next 25. But a check of the forecast of probable growth of consumption afforded by projecting the curve is possible, through an analysis of the reasons for the past increase and a consideration of their probable future influence.

Other things being equal, growth in population would in itself mean a proportionate increase in requirements. The present population of the United States is approximately 110 million. By 1950, according to the best authorities, our population should approximate 150 million. If the per capita consumption remains stationary, this would mean an increase in requirements by 1950 to about 11¼ million tons.

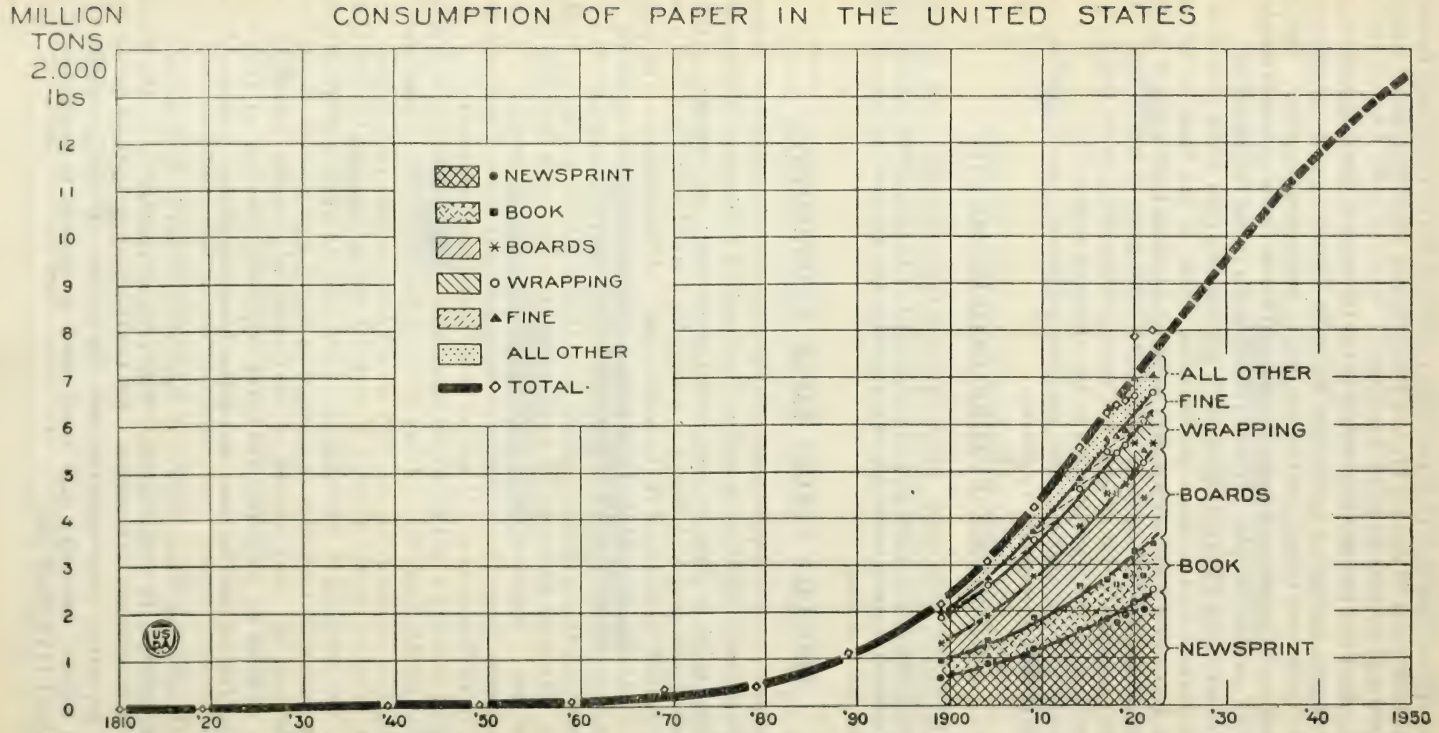


FIG. 21.—During the entire period prior to 1869, before the use of wood, paper consumption in the United States had increased only to 391,000 tons. Since that time consumption based chiefly on paper from wood has increased to 8 million tons. A smaller rate of increase than that of the last two decades would bring consumption in 1950 to 13½ million tons. Paper consumption by grades is shown by cumulative curves.

But during the last half century particularly per capita as well as total paper consumption has advanced rapidly. Between 1899 and 1922 per capita consumption increased 90 pounds, from about 57 to almost 147. An equal per capita increase during the next 25 years would with the predicted growth in population involve a total paper consumption of around 18 million tons.

Some per capita increase is likely, and a considerable increase is possible. High prices due to pulp-wood shortage may play a part in limiting that increase; but they may not play a large part, for reasons that will be brought out later. The increase since 1899 has been in the face of an almost fivefold increase of pulp-wood prices. (Table 41.) Expanding per capita consumption has been brought about partly by the great increase in the quantity of paper used for books, magazines, and newspapers, partly by an even greater increase in the quantity used industrially, in the products classified in Table 3 as "boards," "wrapping," and "all others." Practically half of the 1922 paper consumption was of these classes, with newsprint, book, and fine papers making up the other half. The same causes that during the last 25 years have been pushing upward the quantity of paper used in both fields will continue to have some effect.

A forecast of future trends in per capita consumption calls for separate consideration of each field. Density of population ordinarily stimulates per capita consumption of paper, largely because of the greatly increased volume of printed matter. Advertising accounts for much of this; and although producers and merchants are finding out better how to advertise, signs are not altogether wanting of a popular reaction against the present volume. Publishers are constantly seeking new readers and education is tending to make more. All things considered, the saturation point in consumption of printed matter still seems to be in the future but just how far it is impossible to predict with certainty.

The probability of expanded use of other and possibly new paper grades presents other considerations. The limitations of wood fiber as an industrial material are unknown. Already a pronounced beginning has been made in the substitution of various fiber boards for lumber. The use of paper and board containers of various kinds since 1900 has shown an astonishing growth. Increasing scarcity and cost of lumber may be an important factor in developing new forms of use of a material that can be produced from woods and mill waste, forest thinnings, and quickly grown small stock. Invention has certainly not yet exhausted the possibilities of pulp. A more highly organized industrial life and economic development that will raise the average standard of comfort are also factors that will tend to increase per capita paper consumption.

The possibility that other factors, which can not now be definitely foreseen, will work toward decreased consumption should by no means be overlooked. At some future time, as a result of a combination of causes, the paper consumption curve will flatten out or even reach a peak and decline. Although the former is probable, just which of the two it will be, and when, no one can predict with certainty.

The United States in 1920 manufactured more than half of the world's paper and consumed 98 per cent of that manufactured. To supplement domestic material we purchased from Canada 31 per cent of her pulp-wood cut, and nearly 32 per cent of her pulp output, about one-tenth of Sweden's pulp production, and smaller amounts of pulp from a number of other countries. We purchased also large amounts of foreign paper, the chief item being nearly 78 per cent of Canada's newsprint output. Altogether in 1920 we used 56 per cent of the world's paper. The United States constitutes to-day, and has constituted for 50 years, far and away the world's greatest paper market. (Fig. 22.) In this respect even the most progressive European countries are very poor competitors.

Germany, which is second to the United States in consumption, uses only 20 per cent of what we now require. British per capita consumption is only half of ours, and all other countries fall still further below, as indicated by Figure 23. Even though the extension of the consumption curve in Figure 21 proves to be

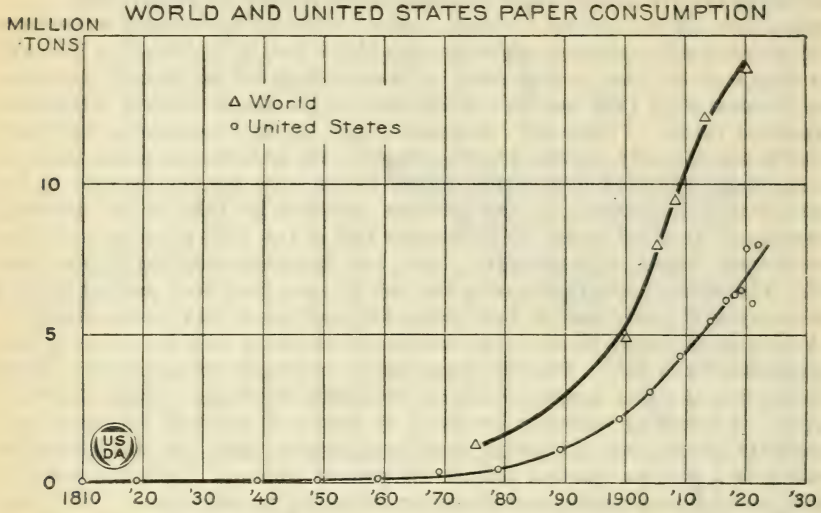


FIG. 22.—The United States is now and has since 1875 been the world's greatest paper market. American consumption in 1920 was 56 per cent of that of the entire world.

in excess of future needs, there is no reason to believe that the United States will not continue for many years to be the world's great paper market. This must be kept clearly in mind in the development of plans to insure future supplies of raw materials. A per capita increase only half that of the last 25 years, with a

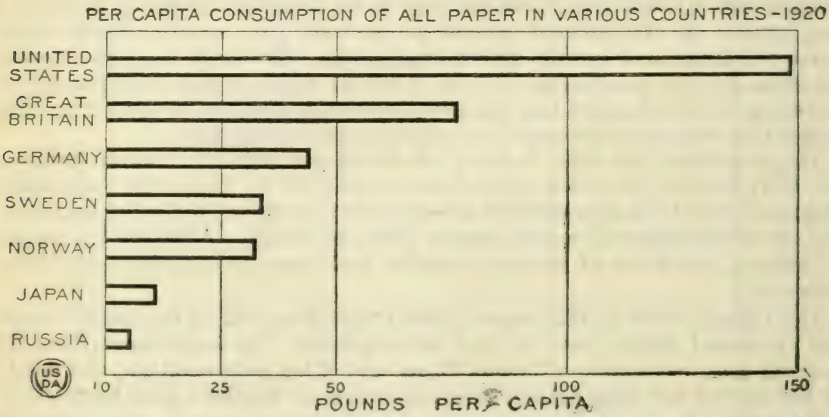


FIG. 23.—Per capita consumption of paper in the United States is twice that of Great Britain, which in turn leads the other countries shown.

population of 150 million, would bring our paper consumption by 1950 to nearly 15 million tons. Plans for future pulp-wood supplies can hardly be made with safety on the basis of paper requirements less than the 13½ million tons shown in Figure 21.

RAW PULP MATERIALS OTHER THAN WOOD.

All plants are potential pulp and paper materials, and a widespread belief still clings that the solution of the paper problem is through the use of other forms of plant growth than wood. Wood is a newcomer in the pulp world. The entire history of pulp and paper making is the story of a search, still continuing, for new and more satisfactory materials. Hardly a day but witnesses the discovery, or more often rediscovery of some new paper-making material. Recent history is covered in a preceding section and need not be repeated. The resultant to date of the competition between wood and other materials, a competition in which properties, availability, costs, and other factors have come into play, is expressed in Figure 1, where wood is shown to be far in the lead of all other materials combined. If, therefore, the present is any indication of the future, wood will continue to be the dominant pulp and paper material.

Among the reasons why materials other than wood have not proved successful for large-scale use the most important are the high cost of assemblage, transportation to the mill and storage, and the fact that many are seasonal crops with comparatively low yields per unit of pulping chemical. In the case of wood the growth of decades can be harvested in a single crop. Furthermore, the paper industry has become so accustomed to handling wood-pulp papers that pulp and paper from other materials are not accepted readily. Each reacts differently under pulping processes and the final product is slightly different and requires special manipulation in handling or printing. These factors have relegated the use of other materials than wood almost entirely to special-purpose papers, many of them of great economic value. The more promising of the materials now known warrant more detailed consideration.

Linen and high-grade cotton rags make a strong, flexible product which is the standard for high-grade book and writing papers. Very little paper even of these high grades is, however, made entirely of rags; wood pulp is usually added, forming as a general average much more than half of the pulp material used. Low-grade rags are largely used in building felts and sheathing papers, where bulk and absorption qualities are necessary. Manila stock, including both rope and jute threads and waste, are used in the strong, porous papers which are so satisfactory as containers for products like cement.

For linen, the best rag stock for paper, the United States is largely dependent upon foreign countries. Demand and hence the price of linen rags is high, both in Europe and the United States; consequently their use is confined solely to very high-grade papers where low cost is not so essential. This automatically restricts use.

Considerable use has been made of cotton rags, but here cost is important, and an active demand immediately advances price.

Straw is now restricted almost entirely to corrugated boards, to which it alone imparts the requisite properties. Straw was once used for printing paper but it has long since yielded this place to wood. Tremendous quantities of straw are available for paper manufacture in the United States, but it is available in relatively small units and present use is confined almost solely to the cereal-producing regions. Straw is bulky and has been costly in comparison with wood. Cost alone has so far eliminated it as a serious competitor for the general manufacture of paper.

Cotton linters have since the war been used to some extent in writing and book papers. This use has been made to supplement the rag supply rather than to compete with wood pulp. Although cotton-linter pulp is made from a waste product, the costs of production are usually above those of a similar pulp made

of wood. Furthermore, paper made from cotton-linter pulp is slightly different in texture and reaction and requires different treatment in manufacture.

The use of bagasse, which is the waste from cane-sugar mills, is relatively recent and is confined chiefly to the manufacture of heavy boards. Many materials, such as kelp, cornstalks, the fibrous waste from other industries, a long list of different plants, and the soft and fibrous minerals, have been tried for paper, but practically all have been rejected, at least for large-scale production. Cost primarily and products differing slightly or greatly in character from those already in use have been responsible.

The use of the nonwood-pulp materials has increased slowly; that of wood very rapidly, in spite of the constantly rising price of pulp wood, at times to levels seemingly prohibitive. The high price of pulp wood of 1920, which in many cases exceeded $30 per cord, still proved to be below the limit which would allow other materials to compete in large quantities. Timber can be grown in large volume, in several regions, for much less than this. Any great use of materials other than wood except for special products or in regions where wood is difficult to obtain and extremely high priced seems improbable in the light of past experience and present knowledge.

PROBABLE FUTURE PULP-WOOD REQUIREMENTS.

Since we shall, in the future, probably have to depend chiefly upon pulp wood as the raw material for paper, it is hardly conceivable that without the most drastic economies we shall ever need less than the present requirements of 9,148,000 cords. At the other extreme, if present conversion factors still hold, a paper consumption in 1950 of 13½ million tons, as indicated by Figure 21, would probably mean in the neighborhood of 15 or 16 million cords of pulp wood. The total would be materially influenced by such factors as the increased or decreased use of waste paper, almost certainly the former, and the higher pulp yields which may be secured through improvement of the chemical processes. Utilization of logging and sawmill waste would reduce the demand upon the forest correspondingly.

While 15 million cords may be an excessive estimate for as early a date as 1950, it is not too large a total on which to base plans for future forest growth. If requirements have not reached 15 million cords by 1950, it is likely that they will thereafter. Any part of it which may not be needed for pulp will certainly be in demand for other products.

Fifteen million cords is, therefore, taken as a reasonable annual production to which we should attempt to bring our pulp-wood supplies within the next two or three decades. If present ratios of utilization continue, nearly 12 million cords of the total would need to be of spruce, fir, and hemlock, 2 million cords of pine, and a little more than 1 million cords of various hardwoods.

There still remains the problem created by the concentration of the industry in limited regions where for many years the timber supplies have been cut so heavily for lumber, and more recently for pulp wood, that they are now much reduced. But the discussion of this phase is so involved in the possibility and ways and means of solution of the entire problem that it is incorporated in the succeeding section.

HOW WE CAN SUPPLY PRESENT AND FUTURE PULP-WOOD REQUIREMENTS.

PRESENT TIMBER RESOURCES, DRAIN, AND REPLACEMENT.

Important factors which require first consideration in the pulp-wood problem of the immediate future, and hardly less in that of the more distant future, are the existing timber resources of the country as a whole, the rate at which they are being used for pulp wood and all other purposes and the additional drain caused by fire and disease, and the extent to which the total drain is offset by new growth. The crucial function of the existing resource is to bridge over the period from the present to the time our forest lands can be made fully productive by forest management. A consideration of the resources of the United States as a whole will accordingly serve as a background for a necessary and more detailed consideration by regions, and in some cases by States.

The pulp and paper industry is full of rumors and suggestions of modified and entirely new pulping processes which it is claimed will make the accepted pulp species available for more general use or even bring entirely new species into the pulp group. It is obviously possible that at almost any time the commercial feasibility of one or more of these processes may be demonstrated and that thereby our conception of pulp-wood resources may be revolutionized. Until so proved, however, all new or modified processes must remain speculative to a greater or less extent, and it will be necessary to base this national, regional and State survey primarily on established usage. The tendency in pulp and paper making, as in all other forms of wood utilization is, however, toward a gradual enlargement of the number of species regarded as suitable, and it would be surprising if in the future, with an increasing timber shortage and with almost world-wide research into pulp and paper-making materials and processes, this tendency was not hastened. The stand of species not now used for pulp and paper making is therefore of more than academic interest, along with the stand of those already in demand.

Less than a third of the original timber stand of the United States remains. Of saw timber, the form in which countrywide estimates have hitherto been considered, we now have approximately 2,200 billion feet, board measure, of virgin and second growth in the United States proper, and an additional 80 billion feet in southern and southeastern Alaska. (Table 44.) Including material below saw-timber size we have more than 3,500 million cords of species now used for pulp and paper, about 55 per cent of the total stand. A much larger proportion of the species and hence of the volume of Alaskan timber is suitable for pulp, and the total is only a little short of 170 million cords.

Of the total stand in the United States about 760 million cords, including jack pine, is suitable for sulphite and mechanical pulp, for which it will be remembered 78 per cent of the wood pulp utilized is now required. Eight hundred fifty million cords are suitable for soda pulp, which now absorbs 8 per cent of our requirements, and the very much larger total of 1,920 million cords is suitable for sulphate, which takes 14 per cent of the total pulp wood needed. (Table 45.) All of the Alaskan pulp species fall within the sulphite-mechanical group.

These totals make the annual pulp wood cut from American forests of 4½ million cords, the consumption of pulp wood by American mills of approximately 1 million cords additional, and even the total amount of pulp wood required for all the paper we consume, look exceedingly small. The remaining timber must, however, meet the requirements for a large number of other important forest products, such as lumber, fuel wood, ties, etc. The annual pulp

wood cut from American forests, although second to no product in economic importance, is now less than 2.5 per cent of the total volume cut for all purposes or destroyed. To supply all of our present requirements and to be entirely independent in pulp wood, pulp, and paper would require less than 5 per cent of the amount of timber now annually cut or destroyed. (Table 48.)

The total annual drain upon American forests exclusive of Alaska falls only a little short of 25 billion cubic feet. While this approximates one-thirtieth of the total visible wood supply of the United States, annual replacement through new growth reaches only one-fourth of the drain, or 6 billion cubic feet. Our timber resource is therefore becoming less by nearly 19 billion cubic feet, or 160 million cords a year.

The general outlook might not be so serious if the cut and destruction were confined mainly to timber of the larger sizes. Unfortunately, however, in the timber below saw-timber size drain exceeds renewal by about three times, so that the possibility of replacing the larger-sized timber is rapidly being reduced. The drain upon the larger-sized material suitable for saw timber is still more excessive, reaching five and one-half times the annual growth.

No other interpretation of these and other known facts is possible than a serious future timber shortage, already in fact beginning for many important products. Data are not available for any very satisfactory comparison of stand, current drain, and growth for all the pulp-wood species taken together, but there is little reason to hope that the situation is much better than for the timber stand as a whole. While a timber shortage will in general be felt first in the high-grade products, such as lumber, an inadequate supply of timber means of course sharper competition among forest industries for the remaining material and higher prices.

In that competition the pulp and paper industry has great advantages. It can use small-sized trees, and it can under the conditions that have hitherto obtained outbid the lumber industry, its chief competitor, for at least the lower grades of saw-log material of the species most in demand by both. The bid of the lumber industry for such stumpage has gone up as regional timber supplies have been cut, but its limit is reached when it becomes cheaper to meet requirements by lumber from other regions. The longer the freight haul from the regions of virgin forests and the greater the stumpage values in those forests, the higher the competitive bid that the pulp and paper industry must be prepared to meet in the older regions. In short, a timber shortage will affect pulp-wood supplies, which will be higher in price and more difficult to get, even though requirements for pulp wood are small in comparison with requirements for other purposes and with our total timber supplies.

Depletion of timber supplies is also bringing an increase in the value of timber below saw-log size and is certain to carry that increase further. In various parts of the East conditions have already reached the point at which the practice of forestry by private owners is good business. As the "expectation value" of young growth is recognized, the competition of the lumber and other forest industries for raw material will more and more make itself felt in the form of higher values placed upon immature timber and in an unwillingness on the part of forest owners to permit cutting of their stands except under the practice of forestry.

This will undoubtedly not be wholly to the disadvantage of the pulp and paper industry in the long run, though at first it may come decidedly as a blessing in disguise. The application of forestry will in time make available for pulp a great amount of small-sized material which should be cut out of growing stands to secure maximum production. Eventually, it is safe to predict, economic conditions will produce a radical change in the character of the pulp and paper indus-

try as related to the forest. Compelled to adjust itself to sustained supplies in place of timber mining, it will attain permanence by supplying its needs either through pulp-wood production as an incident or supplement to the growing of timber for other requirements, or through intensive production of pulp wood solely, on short rotations, under the principles of forestry. Doubtless during the transition period at least self-preservation will require it to resort to both.

This, however, concerns the future rather than the immediate timber situation, already summarized. That situation presents a broad and urgent national problem. On top of it we now face the advisability of an increased cut from our own forest lands to offset present pulp-wood imports, to meet the rapidly increasing demands of the future, and in general to reduce the extent of our dependence upon foreign timber. This is a handicap which must be overcome.

A detailed examination of the widely different conditions in each of the several forest regions offers the only possibility of working out a plan for an increased pulp-wood cut in the immediate future which will not make the general timber situation still worse than it is. Before that is attempted, however, the national aspects of another and closely related resource, the area of forest land and the extent to which it is now being reduced, must be taken into account. Although anticipating a phase of the question which might logically be considered later, the more recent trends affecting the forest-land area are also projected into the future in order to establish an area basis for the determination of potential timber growth under forest management.

PRESENT AND PROBABLE FUTURE AREA OF FOREST LAND.

The area of forest land in the United States has been reduced from its original extent of about 822 million acres to approximately 470 million. After three centuries of continuous struggle the area of improved agricultural lands has grown to 503 million acres, only slightly larger than the residue of forest land.

It has become increasingly evident, particularly during the last four or five decades, that there are very definite limitations to the further encroachment of agriculture upon forest lands. Decades of repeated attempts in the various forest regions have shown that a large part of their land area can not be put to profitable agricultural use. Agricultural economists have been gradually coming to the conclusion that the future tendency in agriculture will be more toward intensive cultivation of the better lands, and that those upon which the margin of profit is small or uncertain, because of poor soil, or climate, or topography, or location, will tend to pass out of agricultural use. In some of our forest regions, in fact, this tendency has been under way for many years, and in many the reversion to forest is proceeding faster than the cultivation of new lands. For the whole United States there has grown up during the past 50 years an area of scores of millions of acres of cut or burned-over forest land which has not been brought into farms, in spite, until very recently, of the greatest popular demand for land in our entire history.

Whether land of relatively low agricultural value has gone into agricultural use up to the present has depended in general upon the ability of the farmer to make a living on it from the production of farm products. In the determination of future land use the possibility of greater profits from timber growing will undoubtedly be a factor. Unquestionably there will be a shifting of forest land into agricultural use in some regions and localities, and the opposite tendency in others. A rough classification of the area under each form of use is gradually being determined by the play of economic forces. The future area of forest land may be slightly less or more than our present area of 470 million acres. Some agricultural economists believe that with higher production and somewhat

modified food requirements a somewhat larger area may be devoted to the growing of timber with full justice to the food requirements of our future population. They are strengthened in this belief by present conditions in the agricultural industry, in which in general the marginal lands are hardest hit. Four hundred seventy million acres may, however, be taken as a fairly close approximation of the area which will probably remain as forest land.

This total does not include the forest lands of Alaska. While there are many millions of acres in interior Alaska a large part of which will unquestionably remain forest land, this report deals only with the forest lands now included in the Tongass and the Chugach National Forests in southeastern and southern Alaska, respectively. For those 5 million acres of forest lands may be added.

Another important factor in the production of pulp wood and of other timber products is the distribution of forest lands in relation to population, and hence to wood requirements. Except for the treeless plains between the Mississippi and the Rocky Mountains the forest-land area is widely distributed. Seventy-five per cent of the total lies east of the Great Plains, in the territory which contains practically all of the larger cities and 79 per cent of our total population. Paper consumption increases with density of population, so that the East is now and will long continue to be the chief area of paper consumption.

Our forest-land resource is still enormous in extent therefore, well distributed in accordance with population, and likely in the future to be at least equal to that of the present. One hundred and thirty-eight million acres is still covered with virgin timber, 250 million with volunteer second growth, and 81 million, devastated by logging and fire, lacks largely or altogether forest growth of any kind.

HOW WE CAN SUPPLY REGIONAL PULP-WOOD REQUIREMENTS.

The preceding discussion of national land and timber resources paves the way for a more detailed regional examination of pulp-wood possibilities. For a complete and satisfactory understanding and for specific answers to all pertinent questions the following data would be absolutely essential:

(1) The size, character, and volume of the present timber stand, by species, and by States and regions.

(2) The present drain, by species, States, and regions, the total drain, and separately the cut for different purposes; and losses from fire, insects, fungous diseases, and windfall.

(3) Forest areas, by types and States.

(4) The present growth, by species and forest types; and by States and regions; its character and rate.

(5) Similarly, potential growth under forest management of varying intensity.

Such ideal data are available for no one region, and much of it is unavailable for any region. The information outlined could be secured by no other means than an exhaustive timber survey such as has never been attempted. Lacking the results of a survey, the discussion is limited correspondingly, and for much of what is given no positive claim can be made of accuracy in detail. The general conclusions reached, however, are believed to be substantially correct.

MIDDLE ATLANTIC STATES.[5]

The pulp mills of New York in 1920 manufactured nearly 60 per cent of the total spruce-pulp-wood imports from Canada, and nearly 50 per cent of that of aspen. Pennsylvania mills purchased nearly 13 per cent and 20 per cent, respectively, of the imports of the same species. Since 73 per cent of the spruce-

[5] The grouping of the States is that followed in the report on Senate Resolution 311 and is shown in Figure 24.

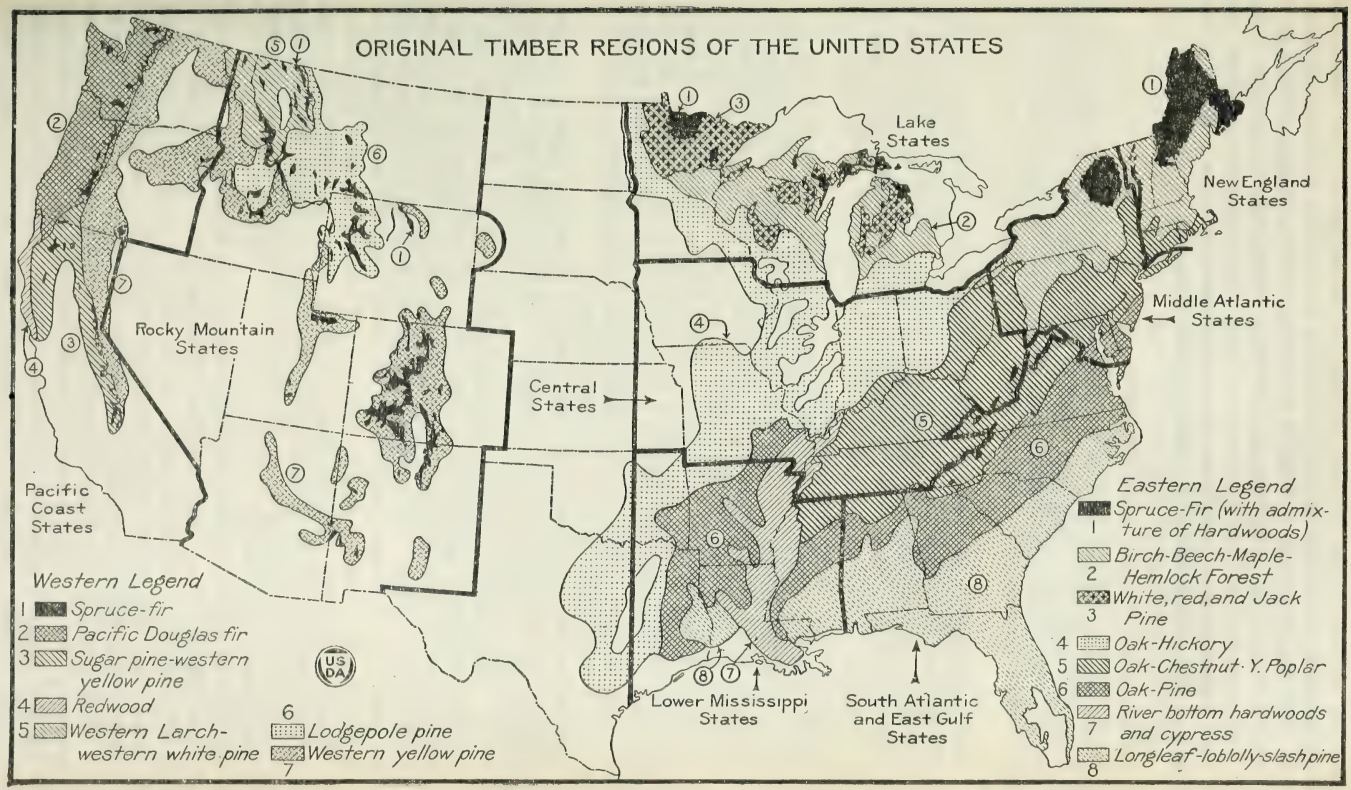


FIG. 24.—The original forest area of the United States was approximately 822 million acres, distributed as shown. Four hundred and seventy million acres remain in forest land, and approximately this area may be counted on for future forest growth. The boundaries of the State groups discussed in this report are outlined in heavy black lines

pulp-wood import problem and 69 per cent of the aspen problem, on the basis of 1920 data, centers in two Middle Atlantic States alone, the first and most critical problem is to determine what provision, if any, can be made in these States to offset these imports. What is to be done for the permanent support of pulp and paper manufacture promises to be almost equally important. The graphic representation of the distribution of the spruce imports in Figure 25, and of the aspen imports in Figure 26 emphasizes still more strikingly the concentration of the problem in the Middle Atlantic States.

NEW YORK.

New York leads all other States in the production of paper. It ranks second in the production of wood pulp and third in the consumption of pulp wood. It produces a very large amount of mechanical and sulphite pulps, and a correspondingly large amount of newsprint paper. Soda-pulp production is much smaller.

The outstanding fact in the present New York situation as to the timber supplies and pulp-wood requirements is the very large and rapidly growing spruce-fir pulp-wood imports from Canada. As recently as 1906 New York imported less than 40 per cent of the spruce utilized in its mills, while in 1920 spruce imports had risen to 59 per cent of consumption. The very large part of the total pulp-wood imports taken by New York has already been stated.

The present stand of spruce and fir in New York, as shown by Table 50, is relatively small, reaching altogether only about 14 million cords. Of this approximately 7 million is on the State preserve, on which cutting is prohibited by the State constitution. Some of the spruce and fir lands are held by lumber companies and as private estates for recreation. The holdings of the pulp and paper companies aggregate about one-seventh of the total spruce-fir stand in the Adirondack region. It is reported that but three or four companies have holdings sufficiently large to carry them 10 years without purchases of additional supplies, and that only one company has a supply for 20 years.

A rather detailed study of the New York situation along the lines of the preceding paragraph indicates that probably less than half of the total spruce-fir stand is now available for pulp and paper manufacture, a total of approximately 6½ million cords. This stand, according to 1920 figures, is being cut at the rate of about 400,000 cords a year for pulp wood, and would prove even more inadequate should it be compelled to supply any or all of the 545,000 cords (1920) additional now imported from Canada. The cut for lumber in 1920 reached an equivalent of 57,500 cords. No data are available to show the cut for other purposes, or the losses by fungous diseases, insects, and fire. The total drain on this forest, which is therefore unknown, is being offset by growth in the spruce-fir type of the Middle Atlantic States, which is confined to New York, of about 300,000 cords per year (Table 49); but because of State and other holdings only about one-half may be available for pulp wood.

Such incomplete and unsatisfactory data as exist are sufficient to show conclusively that the situation is growing rapidly worse rather than better. The many New York mills which are without timber holdings of their own are most directly concerned. Practically all the rest, however, find it necessary to supplement their own inadequate holdings by purchases of pulp wood. Any increase in the cut to offset pulp-wood imports would merely draw more heavily upon the already depleted stands of the State. It would intensify still further the competition between the pulp mills and other forms of use. Imports might be offset in part through increased purchases from Vermont, which, as shown later, might be able to supply its own mills if timber is not diverted outside of the State.

For some mills, or for modified processes, water shipments of pine and hardwoods from the South might be made.

Hemlock, with a total stand in New York about the same as spruce and fir, is so widely scattered and so largely held and under manufacture by lumber companies that the pulp and paper industry has little opportunity to stave off the inevitable by shifting its requirements.

To bring the spruce-fir lands into maximum timber growth under forest management is a question of years, while the necessity of meeting current demands of the immediate future is in the worst cases a matter of months. Without radical changes in the pulping processes, of a character to be discussed later, which would make such species as beech, birch, and maple generally available for other pulps than soda, the gradual exhaustion of local supplies, regardless of any other factors, can therefore mean only one of two things for some, at least, and possibly many of the sulphite and mechanical mills—the manufacture of other materials than pulp, or closing down.

Forestry measures already adopted are good as far as they go. The efficiency of fire protection, under the stimulus of timber scarcity and high stumpage prices and of State and Federal cooperation, is gradually improving. Some stands in the past have been cut to a fixed diameter limit, but other cultural operations and replanting of waste lands to secure full production are still almost entirely in the future.

On the basis of the best data available, it is believed that ultimately under intensive forest management production on the entire acreage of the spruce-fir type in New York could be brought to 920,000 cords, which is practically enough to support permanently the full requirements of the existing industry if all were available. Possibly it could be supplemented enough from hemlock to offset the diversion of spruce and fir to other purposes. Long before that time, however, the wide use of other species by modified processes seems to be the only means of retaining a substantial part of the present development. Otherwise the output of the mills which will pass out of existence must be made up by greater production in the other regions of the United States.

Aspen, with an 85,000-cord pulp-wood import (1920) and a cut from within the State of less than one-third this amount, seems from the unsatisfactory data available to be as seriously jeopardized as a source of supplies for soda pulp as is spruce for sulphite and mechanical. Manufacture could if necessary, however, be diverted to birch, beech, and maple, less desirable but still satisfactory, of which a stand still remains probably large enough to meet requirements until forest management could become fully effective.

PENNSYLVANIA.

Pennsylvania was in 1920 fourth among the States in the consumption of pulp wood. It was first in the production of soda pulp, and ranks high in the manufacture of book paper. It has in common with the New York industry a dependence upon spruce-fir forests for sulphite pulp. Data on which to base specific statements of timber supplies of various species, and the part of the supplies available for pulp and paper manufacture, are very meager and unsatisfactory. Such as warrant specific statement are incorporated in Table 51. It is most significant, however, that of the 17 pulp mills now operating in Pennsylvania only one secures its timber entirely from the State, and all but two others import all of their wood requirements. Seventy-four per cent of the pulp wood used by the mills of the State comes from outside, 45 per cent from Ontario and Quebec, and the rest from West Virginia, Maryland, Virginia, North Carolina, and Michigan. One Pennsylvania company is even relogging old hemlock operations for dead tops, stumps, and old logs. Eighty-five per cent of the 143,000

cords of spruce used in 1920 came from Canada, and 69 per cent of the 53,000 cords of aspen. The combined holdings of the pulp and paper companies in the State are approximately 90,000 acres, practically all owned by one company.

It would seem that the large acreage of forest land within the State bearing in mixture the trees suitable for the soda process should fully meet the State requirements, but for these woods the pulp and paper industry meets severe competition from a very large and active coal-mining industry and from hardwood distillation plants. While, therefore, the soda-pulp industry is in a bad way for supplies, it is not so seriously situated as the sulphite mills.

As it becomes more and more difficult to secure spruce, fir, and hemlock pulp wood, the requirements of the sulphite mills may in part be shifted to other species, for example, to southern pines from outside the State. This under present processes would be possible only for a limited number of mills manu-

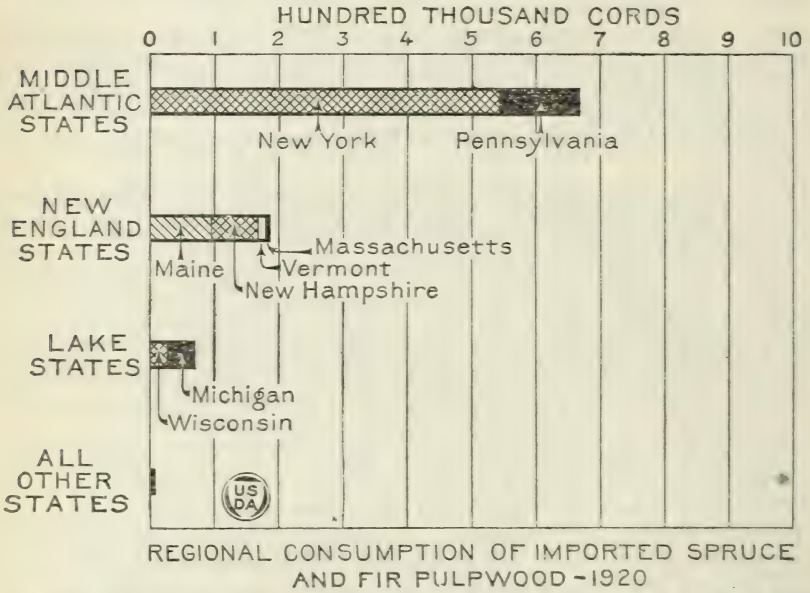


FIG. 25.—The Middle Atlantic States used 73 per cent of the Canadian spruce and fir pulp wood consumed in the United States in 1920, and here the stoppage of pulp-wood imports would hit the hardest.

facturing special products. Sulphite mills might in part be shifted to the soda process, but they would also have to import much of their material from other States. Pulp mills might even in some cases have to shift to other kinds of manufacture as an alternative to closing down altogether. The situation may work out along almost any if not all of these different lines.

Possibly timber growth under intensive forest management on the highly productive forest lands of Pennsylvania would be very great and would include a large but unknown volume of species suitable for soda pulp, and possibly the hemlock needed to support at least a part of the existing sulphite industry. Under intensive forestry there would also be the possibility of imports of southern pine more than ample to meet all present and probably future requirements of the mills which could use it. This will be covered in more detail in the discussion of the Southern States.

The industries in the other Middle Atlantic States—New Jersey, Delaware and Maryland—are relatively small and need not be discussed in detail.

It is clearly apparent, however, that the situation in both New York and Pennsylvania is extremely critical. The gradual exhaustion of local supplies, regardless of any other developments, promises to make the future situation worse rather than better. Any development which produces or accentuates a shortage of supplies will inevitably tend to stimulate the development of the industry in other parts of the United States. Local shortages might be met temporarily by modified pulping processes which would utilize other woods. The only promise in either State, however, for a permanent industry on anything approaching the present scale is through intensive forest management in the forests of pulp species, aggressively applied at the earliest possible date. The sooner and the more intensively it is applied the larger the part of the present industry it will be possible to save and maintain.

NEW ENGLAND STATES.

Next to the Middle Atlantic States, the New England States are most immediately and seriously concerned as to their pulp-wood supplies—Maine and New Hampshire for spruce, and Maine also for aspen. As a group, the New

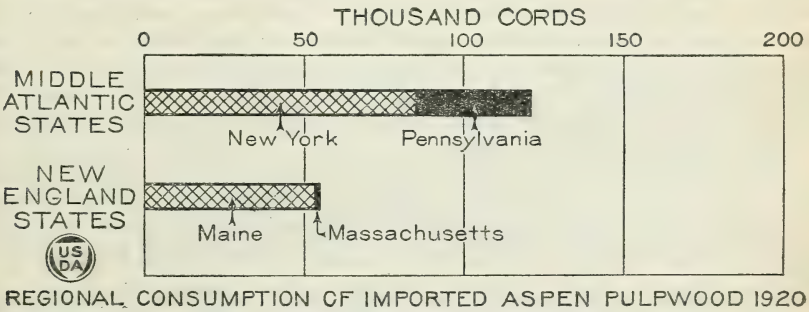


FIG. 26.—The soda-pulp mills of New York and Pennsylvania used 69 per cent of all imported aspen in 1920, and are most concerned as to continued supplies. Maine mills are involved, but in less degree.

England States secured (1920) 20 per cent of the entire Canadian spruce-pulpwood import, and about 31 per cent of the aspen. This relationship to the Middle Atlantic States is shown graphically in Figures 25 and 26. The spruce-fir forest of northern New England is the chief center of the mechanical and sulphite pulp and the newsprint paper industry in the country; Massachusetts plants are devoted primarily to book and writing paper

MAINE.

Maine leads all the States of the country in the production of wood pulp and consumption of pulp wood. The pulp-wood cut is 2½ times that of New York, but the area of spruce-fir forest in the wild lands of the State is more than 4 times as large and the volume of these species available for pulp wood is 3½ times as large, so that Maine has been and will in the future be in a much better position to support its present industry than New York.

Total spruce-fir stands, now probably under 45 million cords, are being drawn upon annually to meet the lumber cut and the pulp-wood consumption of the State which take about 1,470,000 cords, and to supply possibly an additional 75,000 cords of pulp wood for New Hampshire. (Table 53.) The losses from the spruce bud-worm epidemic during the past few years have been estimated at about 27½ million cords. The amount of loss from other insects, fungous diseases, and fire is unknown. The volume of material cut for other purposes

than lumber and pulp, while small, is also unknown. Partly offsetting these drains is the present growth of the spruce-fir type, which for all New England has been estimated at 1,060,000 cords a year. Maine contains about 85 per cent of the type. Entomologists estimate that this rate of growth has been reduced approximately one-third by the bud-worm epidemic, and will so continue for several years.

A rather detailed study indicates that only approximately 34½ million cords out of the total stand is available for pulp. Only 6 of the 17 timber holdings in Maine which contain more than 100,000 acres belong to pulp and paper companies. Such companies hold only about 20 per cent of the wild-land area of the State, on which the spruce and fir are almost entirely located. Excepting the large holding estates, lumber companies now hold between 12 and 18 per cent of the wild-land area, in contrast with the ownership 20 years ago of practically 100 per cent. To supplement their own holdings, pulp and paper companies depend upon Canada and upon purchases from a number of large estates, which for many years have followed a crude system of forestry in allowing the cutting of trees above a specified and progressively lowering diameter limit. This practice and the development of a more and more efficient fire protection, aided by rather unusually favorable climatic conditions, have preserved in Maine a more satisfactory timber supply and growth than in almost any other region. The stand available for pulp is being cut at the rate of about 1,020,000 cords a year for mills in the State, with additional shipments to New Hampshire. Local mills also in 1920 supplemented domestic supplies with imports of approximately 93,500 cords of spruce and fir.

These are the known facts bearing upon the present situation and the immediate future. They do not make it possible to measure either in exact terms, but are sufficiently clear to warrant the conclusion that there are too many entries on the wrong side of the ledger and that it already shows too much of a deficit.

The outlook, unless modified pulping processes can make other species available, is probably an enforced curtailment of pulp and paper production more or less gradual, dependent on developments, which will hit first and hardest the pulp mills without available timber supplies of their own. The cut of many other mills will probably be shifted in much greater degree than at present to their own inadequate holdings, with still more serious overcutting. It is very doubtful if immediate application of the most intensive forestry measures over the entire spruce-fir type of the State can produce results soon enough to prevent such a curtailment. The outlook for the immediate future, although far better than in New York or Pennsylvania, is far from bright. Ultimate future possibilities in spruce and fir production can best be considered for New England as a whole.

NEW HAMPSHIRE.

New Hampshire is much less favorably situated than Maine. The total stand (Table 54) of spruce and fir is probably less than 9½ million cords, and this is being reduced annually at the rate of about 296,000 cords by the cut for lumber and pulp wood alone, and an additional amount by fire, insect infestations, and fungous diseases. The spruce bud worm, while much less serious than in Maine, has been responsible for heavy losses. Growth can be judged only in the light of a total for the spruce type of New England of 1,060,000 cords, and the fact that 10 per cent of the type area is in New Hampshire—at best only the roughest kind of an approximation.

Spruce-fir stands available for pulp and paper manufacture probably fall under 5½ million cords. The pulp mills of the State consume about 300,000 cords of

American wood, of which possibly as much as 100,000 cords is secured chiefly from Maine, but some also from Vermont. They consume also about 75,000 cords from Canada. Unless relief can be secured through new pulping processes, the outlook in New Hampshire is similar to that for Maine but far more serious. The effects of shortages would inevitably be extended in part to Maine and also to Vermont. Except as indicated, curtailment of production seems the only possible outlook. The hemlock supply is relatively small, and is available to such a limited extent that it affords no hope of relieving the situation.

VERMONT.

Vermont offsets its exports of spruce and fir to New York and New Hampshire to the extent of about 10,000 cords, on the basis of 1920 data, by imports from Canada. The data available (Table 55) make it more or less uncertain whether the Vermont mills can continue at their present capacity, even though intensive measures of forest management are immediately put into effect on all of the spruce-fir lands. Unquestionably the margin is too small for any reasonable degree of satisfaction. Vermont, however, is in a very much better situation than New Hampshire, and probably even than Maine.

POTENTIAL SPRUCE GROWTH IN NEW ENGLAND.

The lumber and pulp-wood cut of spruce and fir in the three northern New England States now reaches above 2 million cords a year. Imports from Canada increase the consumption of the pulp mills by 180,000 cords of spruce and fir. The replacement by growth in the spruce-fir type, which has been estimated at 1,060,000 cords, is now temporarily reduced by the spruce bud worm and is offset still further by additional losses of unknown amounts through other insects, fire, and disease. The opportunity for large production under intensive forest management, however, is very favorable. With such management applied to the entire 10 million acres of spruce-fir lands, growth could be brought ultimately to 3,850,000 cords. (Table 52.) Not all of the timber in the spruce-fir type consists of spruce and fir. On the other hand, the beech-birch-maple type includes enough spruce and fir to balance. Future allowance must be made for probable use of spruce and fir for lumber and other purposes. But the total of 3,850,000 cords is so far above present requirements, even when supplemented by imports from Canada, that it will well justify the most intensive efforts to bring it about.

As a stimulus, there is the 1920 cost of $26.78 per cord for imported spruce pulp wood delivered at the mill. This is unquestionably more than enough to cover the entire cost per cord of growing a crop of pulp timber. A large part of this cost grew out of the scarcity of timber, competition among purchasers for the available supplies, and high freight costs for excessive hauls. This is a sum which the pulp and paper industry might better have placed in such part as needed in timber cultural operations on American soil than in freight on Canadian wood. The total possible growth in the spruce-fir region of New England alone falls only about 650,000 cords short of the total 1922 pulp-wood cut of all species in the United States.

SODA PULP WOOD IN NEW ENGLAND.

No consideration has been given to the soda-pulp industry of New England. Maine mills take practically the entire Canadian export to New England, about 54,000 cords (1920) of aspen a year. This volume could possibly be supplied from the scattered aspen stands of the State if it became necessary, and there would still be the entirely feasible possibility of utilizing beech, birch, and maple

instead. Large stands of these species have usually, up to the present, been passed over, and the possibility of growth exceeds those in the spruce-fir type by approximately a million cords a year. Competition for these species for other purposes will grow, however. The mills of Massachusetts can draw upon suitable species from the oak-chestnut-yellow poplar and oak-pine types, which could supply larger quantities than at present.

The situation which must be met in New England is primarily that of increasing the growth of spruce and fir rapidly enough to prevent a serious curtailment in the more immediate future of mechanical-sulphite pulp and newsprint paper production. All of the information available indicates that, without a possible use of other species by new pulp processes, there will have to be some curtailment of production through the gradual exhaustion of domestic supplies. Such exhaustion, even though it is not aggravated by other conditions, will unquestionably tend to force the development of an industry in other parts of the United States. Increased pulp and paper production in the Northeast can only follow timber yields, brought about by intensive forest management, higher than the drain on the forest.

LAKE STATES.

Although the pulp-wood import problem of the Lake States is only 7 per cent of that of the entire United States, these States rank below only the New England and the Middle Atlantic States as a center of pulp and paper production. They manufactured in 1920 over 20 per cent of the wood pulp in the United States, mostly for newsprint paper, and Michigan and Wisconsin have a large production of other papers. The question of first importance, and one of the immediate future, is the possibility of making up from our own forests, if necessary, the 70,000 (1920) cords of spruce pulp-wood imports of Michigan and Wisconsin. The second problem, also one of the immediate future, is the possibility in a region with a well-developed industry of enlarging the scale of manufacture enough at least to offset a possible curtailment in the two State groups already discussed. The third problem relates to the size of the industry which can be maintained permanently in the future, and particularly whether there is the opportunity to reduce our imports of paper and pulp by means of an enlarged pulp-wood cut. These considerations place the Lake States immediately following the Middle Atlantic and New England in point of urgency.

MICHIGAN.

Michigan ranks fourth among the States in paper production, but confines its output almost entirely to book, other high-grade papers, and boards. The total stand of spruce and fir is estimated at 6 million cords (Table 57), half of which is fir so defective that it is a much smaller factor than its total would indicate. The total stand of the State does not make a very good showing in relation to the present lumber cut and consumption of domestic pulp wood, amounting to about 130,000 cords (1920), and further the geographical separation of the upper peninsula, which contains the great bulk of the stand, makes this timber tributary chiefly to the Wisconsin mills. The Michigan mills, most of which are on the lower peninsula, are thrown back on the small scattered spruce-fir areas in the swamps of the lower peninsula, and already secure nearly 40 per cent of their spruce and fir from Canada. With or without imports of pulp wood, the outlook of the immediate future for spruce and fir promises to be worse instead of better.

Hemlock in Michigan is used for sulphite pulp nearly as extensively as spruce. The hemlock stands, three times as large as the spruce and fir, are mostly on the upper peninsula. The lower peninsula pulp mills secure their hemlock mainly

from the upper peninsula, in competition with the Wisconsin pulp mills, from lumber companies which hold and cut most of the timber. A solution of the problem of the immediate future through the greater utilization of hemlock is not so promising as it might be.

The greatest opportunity will be a shift, already in process to the jack-pine stands, which are double those of spruce and fir, although in part so scattered as to be unavailable under present conditions, or under any that are likely to obtain in the near future. Jack pine, however, in case of need may possibly be made to carry the sulphite industry until forestry measures can insure a permanent timber supply. Even this will depend to some extent upon how serious an epidemic of jack-pine sawfly, now apparently beginning in the Lake States, proves to be, and upon the growing demand for jack pine for other purposes. Michigan mills manufacture practically no soda pulp. But there is enough aspen, basswood, beech, birch, and maple on the lower peninsula to support an industry of perhaps 50,000 to 100,000 cords a year. Possible timber production under intensive forest management will be discussed for the Lake States as a whole, the only manner in which the character of the data available justifies.

WISCONSIN.

Wisconsin has for many years ranked third among the States in pulp production, and now approaches New York closely. Its production is confined largely to mechanical and sulphite pulps. It ranks about third in both newsprint and total paper production.

Although only about 27,500 cords of spruce pulp wood were imported in 1920 from Canada, Wisconsin is in about as critical a condition as to available supplies within its own boundaries as any other State. The tendency among the Wisconsin mills has been to acquire only small holdings to tide over possible emergencies, and to depend upon the open pulp-wood or log market for normal supplies. The stand of spruce in the State, probably about 1 million cords, of which only a part is available for pulp wood, is so small that it could hardly supply the spruce requirements of local mills for more than two or three years if they were entirely dependent upon it. Although the total stand of fir is somewhat larger, probably still less than of spruce is available for pulp wood. The hemlock stands, while originally extensive and still amounting to more than 30 million cords, are held very largely by lumber companies, so that aside from their own timber holdings paper mills have to secure hemlock logs in competition with the sawmills. (Table 58.)

In 1920 a representative of one of the companies purchasing pulp wood for a large number of mills stated that spruce supplies for the Wisconsin mills were in 1904 secured largely in Wisconsin, and that in 1915 these mills had to bring their material from farther north, in Minnesota, but that it was rarely necessary to go more than 50 miles north of Duluth. In 1920 a material part of the supplies came from the extreme northern part of Minnesota. Spruce was being hauled in 1920 from 700 to 750 miles by rail from Minnesota to Wisconsin mills, and from 1,000 to 1,200 miles from Canada. Meanwhile, the competition of Minnesota mills, alarmed as to their own future supplies, had become so severe that Wisconsin was forced to secure its spruce in rapidly increasing quantities and at higher freights from the northern peninsula of Michigan.

Most of the spruce and fir now used comes either from Minnesota or the upper peninsula. Competition of Minnesota mills threatens gradually to eliminate that source, and the upper Michigan supply is comparatively limited. For hemlock, of which a much larger stand still remains both in Wisconsin and the upper peninsula, the mills can draw on their own small holdings in both States; to a certain extent they may be able to trade their hardwood timber for hemlock; they can as in the past purchase the poorer logs from logging operations. They

may in more severe competition take higher-grade logs in addition, and they may as heretofore purchase from farmers second-growth hemlock, exceedingly limited though it is, and thereby aid in eliminating the possibility of future hemlock stands. The heavy hemlock cut for lumber, which is nearly twice that for pulp in Wisconsin, the cut for other purposes, and losses from fire, insects, disease, and windfall, the failure of hemlock to reproduce up to the present time except in very limited quantities, and the small holdings of pulp companies, all tend to offset the seeming advantage from the size of the present stand. In spite of these handicaps the cut of hemlock can probably be increased to a greater or less extent for a relatively limited period, possibly for two decades, to offset decreasing supplies of spruce. But there is little promise of any material enlargement of the industry on the basis of hemlock supplies in the immediate future, and there seems to be no chance for a permanent enlargement.

As in Michigan, only the jack pine remains. Wisconsin has a stand of 10 million cords, in part so scattered as to be unavailable and in part certain to be demanded for other use. This can probably be supplemented from the upper peninsula and Minnesota. Entomologists believe however that the jack-pine stands of the Lake States are threatened by an attack of the jack-pine sawfly, and this may reduce the amount available. Just what losses may result, and how they may affect future pulp-wood supplies, it is impossible to predict with certainty. The present sulphite industry can possibly, however, be maintained on hemlock and jack pine until new supplies of the pulp timbers can be grown, if the most energetic efforts to grow them are begun immediately and generally. Otherwise, barring new pulp processes, future curtailment is inevitable, with or without pulp-wood imports. For mechanical pulp the prospects are far less favorable, because it depends chiefly upon spruce, uses hemlock only at a comparative disadvantage, and finds jack pine still less satisfactory.

Possible timber production under intensive forest management will be considered for the three Lake States as a group. It may, however, be stated here that the possibilities of growing hemlock in the future are not very bright under any methods of management now known. The amount of spruce grown in Wisconsin will not be large enough because of the relatively small area of spruce lands in the State. It should be possible to grow very much larger quantities of jack and other pines, from which, if proper methods can be developed, the sulphite if not the mechanical-pulp industry can be perpetuated.

MINNESOTA.

Mechanical and sulphite pulp and newsprint paper are the chief products of the Minnesota mills. Minnesota imports no pulp wood from Canada but rather, as stated, ships a considerable amount into Wisconsin. Fully 99 per cent of the 1920 pulp-wood consumption of the State was spruce, and unfortunately the stand of this timber is relatively small and widely scattered. Because of the latter fact, probably not over half of the total estimated spruce stand of 5 million cords can be counted on for the immediate future, and even less of the 3 million cords of fir, which is defective. (Table 59.) The lumber and pulp-wood cut together, including shipments to Wisconsin, and without the cut for other purposes, losses from fire, insects, and disease are probably nearer 600,000 than 500,000 cords annually. Losses of both balsam and spruce are known to be arge already from an attack of the spruce bud worm which has assumed epidemic proportions. The extent of replacement by current growth is unknown.

According to the best data available, therefore, the future of sulphite and mechanical-pulp making in Minnesota is very precarious if reliance is to be upon spruce alone. There is, however, a much larger stand of jack pine, estimated at 16 million cords, to which sulphite requirements, if not those for mechanical

pulp is being diverted to supplement failing spruce supplies. Unfortunately, however, entomologists believes that an epidemic of jack-pine sawfly, which has already done extensive damage in Canada, now threatens the jack pine of Minnesota and the Lake States. There is also a relatively large stand of aspen of good quality, estimated at 15 million cords, which might be made the basis of a soda-pulp industry of perhaps 100,000 cords a year. This species is now being cut for soda pulp only in very small quantities. There is also a stand of tamarack suitable for sulphate pulp, estimated at 15 million cords, but 60 per cent dead. Dead tamarack, however, remains suitable for pulp wood for a long period.

FUTURE TIMBER GROWTH IN THE LAKE STATES.

The total area of spruce-fir lands in the Lake States is about 4½ million acres, slightly less than half that in New England, but nearly twice that in New York. (Table 46.) Growth under intensive forest management will probably average slightly less than in either. It is estimated that, under intensive forest management upon the entire area, approximately 1,360,000 cords of spruce and fir could eventually be grown each year. (Table 56.) This, for all three states, combined, would leave a margin of about 400,000 cords of spruce and fir in excess of the total 1920 spruce-fir lumber cut and pulp-wood consumption, including imports from Canada. The latter amount would be available to replace hemlock, or for an enlarged pulp and paper production, or for other uses.

Possible growth in the pine type, under intensive forest management, has been estimated at more than 12½ million cords a year. The white and Norway pine of which the stand is composed in part would probably be so valuable for other purposes that they would be available only to a small extent for pulp and paper making. It is reasonable to assume, however, that possibly 1 to 2 million cords a year of jack pine, which is also produced in the pine type, would be available for pulp. In addition to a possible use for sulphite pulp, it is entirely suitable for sulphate pulp. Instead of waiting for the general development of forestry over the entire area of pine lands it would be entirely feasible for the pulp and paper industry to devote a part of these lands to jack-pine production, and thereby meet their own requirements. Tamarack also is suitable for sulphate pulp and may become a factor if the sawfly can be controlled.

Growth in the beech-birch-maple type can also be brought to a very large figure, in excess of 10 million cords a year. Possibly methods of timber growing may be developed under which hemlock can be kept an important species in this type as at present. It is rather to be expected, however, that the 530,000 cords (1920) of hemlock now used for pulp will, after the exhaustion of virgin supplies, have to be secured largely or altogether from other species. In any case the type includes species of value for soda-pulp manufacture, and a large volume compared with present use would be available, notwithstanding large present and probable future demand for these species for lumber and similar purposes.

On the whole, therefore, from the standpoint of timber production alone, there is a possibility, under intensive forest management, of a more varied and a very much larger permanent pulp and paper industry than at present, although there are very definite limitations on the size of the industry which can be supported on spruce and fir alone, and hemlock apparently offers little beyond two decades. Altogether, with a possible annual growth of nearly 31 million cords of pulp species, a pulp cut of any amount up to 5 million cords would not be unreasonable.

PACIFIC COAST STATES.

The preceding discussion of the three State groups where the American pulp and paper industry is now centered clearly indicates the serious objections to enlarging the spruce-fir-hemlock cut sufficiently to make up all or any part of the

present pulp-wood imports of 800,000 to 900,000 cords until the rate of timber growth can be increased through forest management. An enlargement to reduce pulp and paper imports or an expansion to cover in whole or in part the normal future growth in our requirements would be still more out of the question. Unless temporary relief can be secured through new pulping processes, a reduction of the cut is probable or certain in several of the States within a relatively few years under the most favorable conditions which can be anticipated.

To produce at home the pulp and paper now imported, and probably in part at least to absorb pulp-wood imports, it will therefore be absolutely necessary to turn to new regions. The regions which must receive first consideration are those which can furnish large quantities of spruce, fir, and hemlock, since upon these 78 per cent of our requirements depend. There will be great advantages in being able to go to regions with virgin timber supplies which can support an industry while forest production is being got under way. Two regions, Alaska and the three Pacific-Coast States—Washington, Oregon, and California—offer exceptional opportunities in this respect. Almost any new region may incidentally involve the solution of relatively minor technical difficulties as a phase of the development of large new industries.

The opportunity in the Pacific-Coast States for the development of a greatly enlarged sulphite and mechanical-pulp industry is based upon supplies of virgin spruce, fir,[9] and hemlock much larger than in any other forest region of the United States. Still larger stands of pine afford a similar opportunity to increase the production of sulphate pulp and the grades of paper, such as wrapping and boards, of which it forms a part. The three States contain a very large and well-developed lumber industry, which is still expanding rapidly, so that any enlargement of a pulp industry must, to some extent at least, compete with other use of timber. While the national forests of the coast States contain large amounts of timber, still more is in private ownership.

The Pacific Coast States contain of all species about half of the remaining saw timber of the United States. They contain about one-fourth of the stand of pulp species in cords. More than one-third of the total stand of these States, or nearly 900 million cords (Table 60), consists of pulp species, and a little more than 400 million cords of the pulp species are suitable for sulphite and mechanical pulp, while all of the remainder is suitable for sulphate.

It was estimated in 1920, in the report on Senate Resolution 311, that the total drain on the forests of this region exceeded replacement by growth by about three and one-half times. This is partly due to the large cut, supplemented by fire and disease, and partly also to relatively large stands of virgin timber, in which such growth as occurs is offset by the deterioration of the old trees. Utilization for lumber still leads by far all other forms, probably constituting 95 per cent of the total cut. Washington has, in fact, led the country in volume of lumber cut since and including 1905, with the exception of one year.

SPRUCE-FIR-HEMLOCK PULP WOOD FOR SULPHITE AND MECHANICAL PULP.

Half of the 400 million cords of sulphite-mechanical pulp timbers is western hemlock, and the remainder Sitka spruce and various true firs, obviously not including Douglas fir. The hemlock and spruce occur almost entirely in Washington and Oregon, the fir in all three States. Sitka spruce occupies a relatively small area on or near the coast. Hemlock, while sometimes in pure stands, ordinarily occurs in mixture with spruce or frequently with Douglas fir. On the high slopes of both the Cascades and the Sierras are pure stands of various firs, but ordinarily this group of species is found with other trees in practically all of the types of the region. The scattered manner in which some of the trees occur, the inaccessibility of a part of the stand, and the loss of some of the mate-

[9] Includes the true firs but not the species known as Douglas fir.

rial in logging operations will make a large but uncertain amount unavailable for pulp and paper manufacture.

Lumbering operations of the past have commonly discriminated against hemlock and the firs. Very often a large part of the hemlock found in Douglas fir stands has been left because it could not be manufactured profitably into lumber. This is less true to-day of hemlock, because general depletion of timber supplies has brought a growing appreciation of its intrinsic value. It still holds true, however, of much of the fir. The spruce occurs in quantity in a relatively limited territory, so that, all things considered, the cut of the mechanical-sulphite species for lumber has been small up to the present. In 1922 it reached, in fact, only about $1\frac{1}{4}$ billion board feet out of a total lumber cut for the three States of about $10\frac{1}{2}$ billion board feet.

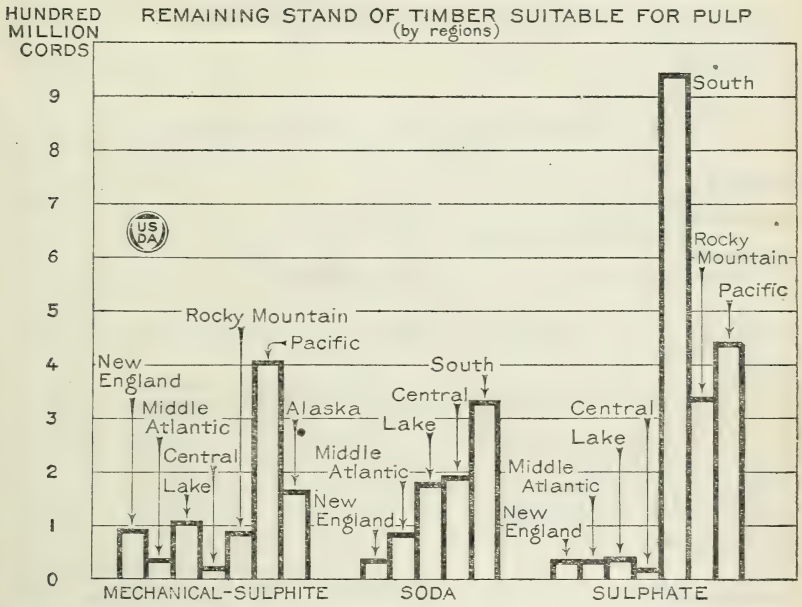
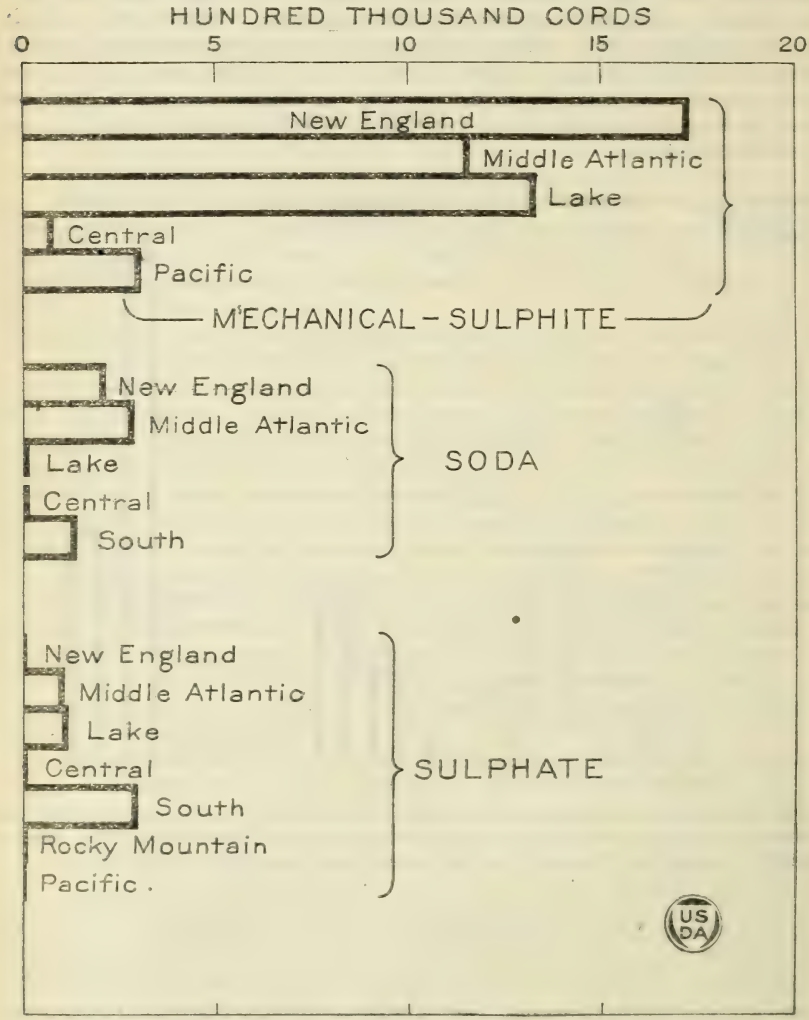


FIG. 27.—The immediate availability of the remaining pulp-timber supplies is greatly reduced by their distribution, the great bulk of the stand being in regions which now have few pulp mills. Pine constitutes a very large part of the remaining supply, but present demands are relatively small.

A comparison of the total stand of spruce, fir, and hemlock on the Pacific coast with that of regions now using similar species for pulp will give a somewhat better idea of the possibility of an enlarged pulp-wood cut than a mere statement of total stand. The total stand in the Coast States is more than six and one-half times that of related species in New England, but the cut for all purposes is smaller in the West by nearly 450,000 cords. The three Western States contain more than 10 times the spruce, fir, and hemlock stand of New York and Pennsylvania, but the cut of the latter States is more than half that of the Western States. The relationships outlined, of stand to present cut, are shown graphically in Figures 27 and 28. We are now taking approximately 3,345,000 cords of pulp wood alone from the spruce-fir-hemlock forests of New England, the Middle Atlantic, and the Lake States combined. The Pacific Coast States, with twice the total stand, could probably, with anything approaching the same standard of utilization as in the East, be expected to furnish an equal amount in the near future. This would mean an increase of more than 3 million cords

over the 274,000-cord pulp-wood cut of 1922. There is no apparent reason why the use of these species in the Pacific Coast States for pulp wood should not become the dominant use.

Washington, in which logging operations are most fully developed, contains by far the largest amount of spruce-fir-hemlock timber on the Pacific coast. A



REGIONAL CONSUMPTION OF PULPWOOD BY PROCESSES, 1920

FIG. 28.—The pulp-wood cut is now centered in the Middle Atlantic, New England, and Lake States, where, as shown by Figure 27, the remaining stand of pulp timber is relatively small.

field study into the possibility of securing pulp wood from logging operations was made in 1920 in the part of the State west of the Cascades. It showed the possibility of securing at that time approximately 500,000 cords a year of low-grade hemlock, spruce, and fir logs, which have usually been difficult to sell and which could undoubtedly be used more advantageously for pulp. It was found that

it would easily be possible to secure from the area logged over annually, an additional 135,000 cords, by taking out material of saw-timber size but a little smaller than that which is now logged for lumber. Without, therefore, taking into account the possibility of utilizing a very large amount in small trees and broken material now left in the woods, and of using sawmill waste, the study disclosed the possibility of securing 635,000 cords of pulp wood from 1920 operations designed primarily for lumber.

There is no reason other than lack of pulp-wood markets why there should not be operations in Washington designed primarily to secure pulp wood, or why operations in stands containing a large percentage of pulp species should not be designed to secure saw timber from the material most suitable for that purpose and pulp wood from the remainder of the stand. There are great possibilities in the integration of the lumber and pulp industries, which, as will be shown later, would make entirely feasible large use of both logging and sawmill waste for pulp.

Furthermore, as the lumber cut of Washington increases during the next decade or so, which it promises to do, the amount of pulp wood available in connection with lumbering operations should increase. More and more as these operations proceed they will include stands of timber with higher percentages of the pulp woods and lower percentages of the Douglas fir, which is now chiefly sought. This might for some time offset largely or altogether a gradual falling off in the lumber cut in Washington, the beginning of which may not be more than a decade or so ahead.

The total stand of timber in Oregon is larger than in Washington, but the percentage of pulp species is lower; and except for the fir stands on the higher slopes of the Cascades the pulp species are more scattered in mixtures with other timbers. The amount of timber in Oregon now inaccessible is relatively higher than in Washington. It is reasonable to expect, therefore, that the pulp timber which will become available in the immediate future will be largely in connection with lumbering operations. The anticipated decrease in lumber cut in the South is certain to stimulate that of Oregon, and this should afford an increasing opportunity to utilize the pulp timber which occurs in mixture. In fact operations designed to secure both saw and pulp timber can be made more advantageous than for saw timber alone. Practically all of the pulp wood cut in Oregon now comes from lumbering operations.

Fir occurs in considerable quantities in the California pineries, and it should be possible to remove it economically for pulp wood in connection with lumbering operations. In California reliance can also be had upon the pure fir stands of the upper Sierra slopes. The sulphite and mechanical output that can be developed in California, however, is smaller than that in Washington or Oregon.

The question of available water power is also an important consideration in connection with an enlargement of the pulp and paper industry, and particularly in connection with the manufacture of mechanical pulp. Part 2 of Senate Document 316, "Electrical power development in the United States," places the estimate of the total potential water-power resources of the States of Washington, Oregon, and California at approximately 11½-million horsepower minimum, as compared with a little less than 28 million for the entire United States, and slightly more than 23-million horsepower maximum, as compared with the total of slightly less than 54 million for the entire United States. Water powers, potential if not developed, are accordingly large enough to encourage rather than retard any possible enlargement of the pulp and paper industry. Since the cheapest and most accessible powers have generally been developed and are in use by other industries, water power for an enlarged pulp and paper manufacture would be more expensive than in Alaska.

Within the time available it has been impossible to study the economic possibilities of competition by the west coast industry in eastern pulp and paper markets. Washington mills in 1920 paid on the average $10.90 per cord for hemlock and spruce pulp wood, delivered at the mill, while New York mills paid $25.01 per cord for spruce under the same conditions. This one item of cost of wood at the mill would go a long way toward offsetting the freight on paper from the west coast to Atlantic ports. An enlarged future demand would on the one hand tend to increase prices through competition for stumpage, and on the other to reduce the cost of delivering pulp wood at the mill through a larger, better established, and more effective organization for this purpose.

The future possibilities of a mechanical-sulphite pulp industry on the Pacific coast, present pulping processes considered, depend primarily upon the yields which can be secured of spruce, fir, and hemlock under intensive forest management. Unfortunately no data are available which show separately the potential growth of these species. They occur primarily in mixture with nonpulp species, and the growth and yield figures available cover types rather than individual trees. The greater part of the existing stand occurs in what is classified as the Douglas fir-spruce-hemlock type, which on the Pacific coast includes an area in excess of 25 million acres. (Table 46.) While present growth of this type falls somewhat short of 5½ million cords a year it is estimated that under intensive forest management production could ultimately be increased to more than 24 million cords. From this total it would appear entirely feasible to maintain permanently a pulp and paper industry consuming from 3 to 3½ million cords a year. This is the approximate volume already indicated as that to which the spruce-fir-hemlock cut of the near future might be increased.

In this survey it must be kept in mind that possible growth in the Douglas fir-spruce-hemlock type is much faster than in the corresponding types of the Northeast and the Lakes States. While the average possible growth under intensive forestry for the spruce-fir type in the Northeast as a whole is estimated at 45 cubic feet per acre per year, and in the Lake States at 35 cubic feet, that for the coast Douglas fir-spruce-hemlock type has been placed at 112 feet. The possibilities in the Northeast, on small tracts under exceptionally favorable conditions, of 80 cubic feet per acre per year may be increased on the Pacific coast to 170 cubic feet. Assuming the production of pulp species alone, it would require an area of only approximately 8 million acres on the west coast to produce our total spruce-fir-hemlock pulp requirements of about 7,170,000 cords. This area is only a little over half of the forest area of Maine. Production of the 3½ million cords indicated for the Pacific Coast States would require only 4 million acres, with correspondingly larger areas if nonpulp species or if less intensive methods of management were involved. It would be entirely feasible, if the pulp and paper industry desired, to produce its future requirements on a relatively small aggregate area.

Still another future advantage lies with the Pacific coast forests. Growth is so rapid that pulp wood may be produced on very short rotations. While rotations of 50 years as a minimum will probably be necessary in the eastern spruce forests, it should be entirely feasible with similar standards of utilization to grow spruce, fir, and hemlock in the Pacific Coast States on rotations of 30 years.

PINE PULP WOOD FOR SULPHATE PULP.

The preceding discussion has dealt entirely with possibilities of sulphite and mechanical pulp production. The three Pacific Coast States, however, contain more than 490 million cords of pine and other species suitable for sulphate pulp.[10]

[10] The possibility of using Douglas fir for sulphate pulp is not taken into account although a small volume is now being used. A very small amount of Douglas fir is also being used with cottonwood in the manufacture of book paper. The existing stand of Douglas fir is very large, probably two or three times that of pine and other species suitable for sulphate pulp in the Pacific Coast States. The possibilities for growing Douglas fir are also very large.

(Table 60.) Nearly all of this timber is pine, and mostly western yellow pine. The total drain upon the sulphate-pulp species probably reaches about 3½ million cords annually, and it exceeds the current growth six or seven times, for essentially the same reasons as those given in the case of the sulphite-mechanical pulp species.

Under intensive forestry, however, it should be possible to grow annually in excess of 12½ million cords. Much of this will be needed and cut for saw timber, but a large volume would undoubtedly be available for sulphate-pulp manufacture from thinnings and defective logs and trees. Western yellow pine particularly makes a very satisfactory wrapping paper. Under forest management it should not be difficult in the future, if not immediately, to secure from the pine stands of the Coast States any desirable part, or all, of the 773,000 cords of sulphate pulp wood now imported in one form or another from Canada and Europe, or in addition, to take care of the annual increase in requirements of 110,000 cords for some years to come.

ALASKA.

Alaska, as already indicated, is one of the two outstanding regions with large virgin supplies of softwoods adapted to sulphite and mechanical pulp. As compared with the Pacific Coast States, Alaska has the advantage of practically pure stands of these species of pulp timber, lower stumpage prices, and cheaper power. It has the disadvantage of being considerably farther from the large paper markets, and of pioneer conditions which would tend to hamper the development of an industry. Ordinarily the pulp and paper industry has followed lumbering, and has either had to displace the sawmill through competition or to take the material which the sawmill left. In Alaska, however, cutting operations for lumber and other purposes are small, so that in this respect there would be a greater opportunity for the development of a dominant pulp and paper industry than in the Pacific Coast States.

To insure the development of the pulp and paper industry on the basis of continuous and permanent supplies ample to meet requirements, the area of the two national forests in Alaska, to which this discussion is confined, has been divided into allotments or compartments. Each of these compartments is of such a size and character that with available timber resources and water power a pulp plant will be permanently supported and such additional timber furnished as may be needed by sawmills for local needs. Under this plan there can be no overdevelopment of manufacturing plants in relation to raw material.

The forest itself forms the northernmost extension of the heavy coast forest of Washington and Oregon. In the western part of the area under consideration it merges with the interior forests of white and black spruce which extend entirely across the continent from the Atlantic. Sixty-five per cent of the 80 billion feet, board measure, consists of western hemlock, already proved by actual use to be a satisfactory sulphite-pulp-wood species; and an additional 20 per cent or more consists of Sitka spruce, comparable in its properties for both mechanical and sulphite pulp with the various spruces of the eastern United States and Canada. While these species are suitable for construction and box material, general lumber requirements, piling, and similar purposes, and are being so used in increasing quantities, the general belief of those most familiar with the Alaskan forests is that their great future use will be for pulp and paper. This is especially true of the Tongass National Forest, in southeastern Alaska, which contains more than seven-eighths of the total stand.

With due allowance for the probable cut into other products and with consideration of the timber below saw-timber size, these forests unquestionably

contain 100 million cords available for pulp wood, and probably even a larger amount. The estimates are based upon intensive cruises covering nearly 600,000 acres, upon more extensive cruises covering nearly 800,000 acres in addition, and on a general knowledge of the remainder of the area. The surveys have disclosed stands running as high as 200 cords to the acre. An average stand of nearly 40 cords to the acre was found on one large pulp and paper tract.

The pulp and paper industry can no longer afford to locate in new regions on the basis of existing stands of timber alone. It must inquire also into the productive capacity of the soil and the timber species which can be grown. The heavy rainfall of southeastern Alaska insures rapid growth, not equal, to be sure, to that of western Washington and Oregon, but probably far in excess of anything that can be hoped for in the Middle Atlantic, New England, and Lake States. Using only the estimated growing rate of the spruce-fir forests of New England, the Alaskan forests will easily produce 2 million cords of pulp timber each year. From the standpoint of permanent supplies, it will be safe, in the judgment of the best informed foresters, to develop in the immediate future a pulp and paper industry up to these requirements.

The production of the Alaskan forests is more than twice enough to make up the 800,000 to 900,000 cords of spruce-pulp-wood imports from Canada. It would take up for eight and one-half years the normal annual increase of 237,000 cords of spruce, fir, and hemlock for sulphite and mechanical pulp. It is more than half of our total dependence for pulp wood, pulp, and paper from all countries, equivalent to 3,916,000 cords, derived from these species. The total cut of spruce and fir for Canadian mills was 2,660,611 cords in 1922. Alaska has frequently been described as a second Norway in its possibilities for pulp and paper making. Yet the Norwegian industry consumes only about 1 million cords a year, and that only by overcutting. Swedish consumption has reached about 3 million cords.

The pulp and paper industry can not, however, depend upon timber supplies alone. Abundant and cheap water power is equally essential, especially in the manufacture of mechanical pulp. It will require not to exceed 500,000 horsepower of continuously available power to convert 2 million cords of pulp wood a year. Four hundred thousand horsepower is already known to be available in southeastern Alaska, 325,000 horsepower of this in sites or groups of 5,000 horsepower or more that can be developed economically for pulp manufacture. These statements of water-power resources are based upon data collected in a systematic survey which the Forest Service has had under way for a number of years, in cooperation with the water-resources branch of the United States Geological Survey and with the Federal Water Power Commission. Intensive surveys have still to cover half or more of southeastern Alaska. A considerable but unknown amount of power can be developed from the flood waters of large rivers for about six months of the year. A few airplane flights over southeastern Alaska have indicated a large number of lakes which had not previously been mapped but some of which will undoubtedly be of value for storage purposes. Economic development and ability to pay higher prices for power will increase the number of sites that can be developed.

To conditions favorable to the development of a pulp and paper industry must be added suitable mill locations and deep-sea transportation. Mills can be located within easy and cheap towing distances from adequate timber supplies. Sheltered channels afford yearlong deep-sea transportation, and the advantages which such transportation affords for incoming supplies and for outgoing products.

Both timber and power can be secured from the Forest Service and Federal Power Commission, respectively, under terms which President Harding in his Seattle speech on Alaska described as follows:

"I venture, with some knowledge of conditions in various paper-making countries, to state that no better contract, indeed none so good, can be secured in any of them."

The development of the pulp and paper industry has unquestionably been retarded by the pioneer conditions which obtain in Alaska. The relatively few settlements are rather widely scattered. This means, among other things, the lack of local skilled labor, particularly for a new industry, which would also have to contend with a lack of local supplies and with the absence of machine-shop facilities. These conditions would necessitate the carrying of larger stocks at the plant and relatively long delays in securing new materials and parts by boat from the Pacific coast or by the Canadian railroads.

Capital moves slowly into new regions, and this is especially true in industries, such as pulp and paper manufacture, requiring large initial investments. While the great development of pulp and paper manufacture in the United States has come during the last three decades, the failure to meet American demands has increased most rapidly during the last decade, a period much of which has been so unsettled as to make pioneering efforts especially hazardous. American capital has gone to the eastern Canadian forests, which are nearer to American centers of consumption and in which conditions are more comparable with those in the Northeastern and Lake States. Alaska has seemed very remote, and until recent years there has been an absence of the detailed, authoritative data necessary to secure real interest on the part of capital. Ocean freights, with a relatively small volume of traffic, have been high. Alaskan timbers are suitable for newsprint production, and until the war newsprint prices particularly were relatively low.

Neither time nor the funds available have permitted an attempt to secure exact data on the possibility of successful competition of Alaska in eastern pulp and paper markets with Canada, or even with American mills. A few significant facts, however, will be given. Average prices paid by American mills for imported spruce were $27.98 per cord in 1921 and $21.87 per cord in 1922. Since these were average prices, many mills must have paid more. In one large pulp unit on the Tongass National Forest, the timber on which was recently sold, it was estimated that, exclusive of a purely nominal figure for stumpage, the cost of pulp wood at the mill from the more accessible timber on the area would not exceed $5.50 per cord, and that for the entire sale area the cost would be approximately $8 per cord. These estimates are based on 1923 wage scales and mill costs. They leave a large margin for the payment of freight from Alaska to eastern markets, as compared with spruce-pulp-wood prices of 1921, or even 1922. This is particularly true if the concern which undertakes a pulp and paper development finances its own system of ocean transportation.

SOUTHERN STATES.

Second in importance to our dependence for sulphite and mechanical pulp woods is that for sulphate pulp wood. As shown by Figure 27, the southern-pine States from Virginia to Texas contain far and away the largest supply of suitable timber and have the additional advantage of easy access to the principal markets of the country. Two-thirds of the timber stand of these States, or nearly 1,300 millon cords, is of species used to a greater or less extent for pulp (Table 61), and the greater part of this is pine.

The South Atlantic and Gulf States, considered separately in the report on Senate Resolution 311, are here combined because of similarity of conditions and

of pulp timbers. They contain nearly 178 million acres of forest land. (Table 46.) The States of this region have, since the passing of white-pine supremacy, led the country in lumber production, but the cut of pulp-wood timber ha always been insignificant. In 1920 it reached only about 440,000 cords, not including slabs and waste. The virgin stands which have largely supplied the lumber cut of the past are fast disappearing.

SPRUCE AND HARDWOOD PULP WOOD.

Less than 10 million cords of the total stand are of the spruce-fir-hemlock group, the stands of which are very heavy and occupy a relatively limited area on the higher slopes of the southern Appalachian Ranges. These stands, while of great present value, have much less significance in an enlargement of the existing industry or the development of a permanent pulp and paper industry than similar amounts of the same species in either New England, New York, or the Lake States. The possibility of reproducing these forests is much less certain, so that no safe prediction can be made as to their future as sources of pulp-wood supplies.

Various soda-pulp species—cottonwood, birch, beech, maple, yellow poplar, basswood, and red, black, and tupelo gums—are scattered over an enormous territory and aggregate 335 million cords. The remaining virgin stands are chiefly in the lower Mississippi bottom lands and along the Gulf coast. A large part of the other hardwood stands have been more or less heavily and repeatedly cut over in the past. Considerable areas are now chiefly valuable for fuel or pulp wood. While cutting far exceeds growth, there are undoubtedly many areas from which a large volume of pulp material could be taken as thinnings and improvement cuttings, and in fact its removal might be made to constitute one step toward better forest management. It should easily be possible to take care of our present shortage of 196,000 cords of soda-pulp-wood timber from this territory if proper methods of forest management begin with the cutting, and to enlarge this at the rate of 23,000 cords a year to absorb our increasing needs for years to come. Relatively small areas could, if worked for pulp timbers alone, be made to produce the entire volume required.

PINE PULP WOOD FOR SULPHATE PULP.

Three-fourths of the pulp stand consists of various species of southern yellow pine, amounting to about 940 million cords. (Table 61.) Under present pulping processes it is being utilized almost exclusively for sulphate pulp and wrapping paper and boards. A bare beginning has been made in its use as bleached sulphate pulp for book paper in substitution for sulphite pulp. The commercial feasibility of this practice has been demonstrated, and wider use is a distinct possibility. There is also the possibility of substituting pine, in part at least, for the spruce and hemlock used in sulphite and sulphate pulp for wrapping paper and boards. Potentially, as will be shown, there is the further possibility of using pine in larger quantities in a modified sulphite process. With present practices as the standard, however, the chief demand for this enormous southern pine resource will be to relieve our dependence for sulphate pulp.

The cut of southern pine now exceeds its growth by about three times. Such second growth as we have is almost entirely voluntary. Most of the stands, in fact, have persisted in spite of destructive lumbering and equally destructive naval-stores operations, and annually or periodically recurring fires. With a certain amount of care, the leaving of a few trees in cutting, fire protection during the critical stages of tree development, and similar measures, the growth of the

southern pines could be enormously increased. With a reasonably distributed industry and with the immediate adoption of forestry measures there should be no difficulty in taking care immediately, in the South alone, of our present total dependence upon foreign countries for an equivalent of 773,000 cords of sulphate pulp wood and of the annual increase in our needs of 110,000 cords a year. The demand for small material for pulp wood would undoubtedly stimulate rather than retard the interest in timber growing in the South through increasing the value of the product. Much of the material needed for an enlarged southern paper industry dependent on pine could be secured from desirable thinnings and from small or defective logs. Even without forest management the pulp and paper industry could probably expand in the South through ability to take a good deal of timber away from the lumber industry in a competitive market; but this could not be particularly desirable from the standpoint of the public.

The southern pines occur in both the southern-pine and the oak-pine type. Possible growth of the pine alone under intensive forestry is estimated at more than 40 million cords a year. Much of this will be needed for saw timber, fuel, and other purposes, but the total dwarfs present sulphate-pulp requirements of 1,220,000 cords and the current rate of increased demand so greatly that there should be no difficulty in meeting enormously enlarged future needs, provided the adoption of intensive forestry methods precedes or at least accompanies the development of the industry. If future developments make possible the use of pine for other pulps, a very large volume of pulp wood will be available. Some of the possibilities of such developments are discussed later. The pulp and paper industry has also the opportunity to devote relatively small areas exclusively to pulp-wood production. The total sulphate requirements could be grown on 2 million acres, for example.

Here, as in the West, is the opportunity for producing material of pulp-wood size in very short rotations. Fifteen to twenty years in the South will produce large yields of thinnings, which can be repeated periodically until it is desirable to remove the remaining stand for either lumber or pulp wood, or for both.

Other conditions is the South are believed to be favorable for an immediate and permanent future enlargement of pulp and paper making. The southern mountain streams furnish ample power. Forest lands occur in both large and small holdings. A pulp and paper concern has before it the alternative of acquiring its own lands or of placing its dependence upon the timber grown upon farm wood lots, or other and larger holdings. Operators desiring to locate in the South and to acquire their own timberlands are not restricted to denuded forest lands. It is easily possible to secure at relatively low prices partly grown stands for future needs, as well as timber already large enough for pulp.

In much of the South there is the possibility, with long-leaf and slash pines, of combining naval stores with pulp production or of combining both with lumber production, and finally of extracting the resinous products from the pulp wood itself. The South has a distinct advantage over the western pine stands in pulp and paper manufacture on account of the handicap to the Western States of distance from the great eastern and middle western markets.

ROCKY MOUNTAIN STATES.

The Rocky Mountain States afford an opportunity for enlarged sulphite and mechanical pulp operations in the near future, but to a much smaller degree than the Pacific Coast States or Alaska. They afford a similar opportunity for sulphate pulp, but here also in much smaller degree than in the Coast States or the South. The opportunity in both cases is based, as in Alaska and the Pacific Coast States, on remaining supplies of virgin timber.

The Rocky Mountain States embrace a large territory of varied forest conditions. The northern Idaho and western Montana forests are similar in many respects to those of the Pacific coast in Washington and Oregon. Relatively heavy stands of western yellow pine in the north grow gradually lighter to the south. Large areas are occupied by lodgepole-pine forests, resembling the jack pine of the Lake States. The forests of various mountain ranges, except in some cases in the north, are widely separated by open, treeless country.

The Rocky Mountain States now support fewer pulp and paper mills than any other forested region of the United States. This is partly a matter of density of population and local demand for paper, partly the economic impracticability up to the present of shipping pulp or paper long distances by rail to the markets of the Middle West and East. The handicap of the rail haul as contrasted with a possible water haul from the Pacific Coast States and Alaska may gradually disappear with increasing population in the Rocky Mountain and Middle Western States, the growing demand for pulp and paper, and the inability of eastern and western forests to meet requirements.

SPRUCE-FIR-HEMLOCK PULP WOOD.

More than four-fifths of all the timber of the Rocky Mountains is of the pulp species, estimated at 440 million cords. (Table 62.) The stand of 88 million cords of spruce, fir, and hemlock is larger than that of New England, much larger than that of the Middle Atlantic States, and nearly as large as that of the Lake States. Except in central and northern Idaho and northwestern Montana, however, the sulphite-mechanical pulp species are much more scattered and hence correspondingly less available. A part of the Idaho and Montana timber is inaccessible under present conditions.

Northern Idaho supports a well-developed lumber industry, the tendency of which has been, as in the Pacific Northwest, to pass by the spruce-fir-hemlock group of pulp species. Practically the only cut of the latter is for lumber, and for that the cut is small. A large amount of timber apparently suitable for pulp is being left on cut-over areas. A large portion of the central Idaho material is still inaccessible. There is an opportunity in the Engelmann spruce, fir, and hemlock stands of northwestern Montana for an enlargement in the immediate future of the sulphite and mechanical pulp output. Here the percentage of the spruce-fir-hemlock group is larger than in northern Idaho, and the lumber industry is much less developed, so that there would be fewer handicaps in securing material for pulp and paper mills. Water power is ample.

A great opportunity is afforded to increase the pulp-wood cut by a proper coordination of the lumber and the pulp and paper industries in logging, and the use by each of the material most suitable for its products. Such an arrangement should aid materially in reducing the amount of wood now wasted in logging operations because of lack of market, and could even include the use of sawmill waste for pulp manufacture. Pulp requirements need not, however, be secondary or incidental to lumber. They can, in fact, constitute the dominant use for spruce, fir, and hemlock.

Unfortunately, growth data for the species of the spruce-fir-hemlock group are not available, since they are ordinarily mixed in types containing nonpulp species. A part of the growth under intensive forest management in the Douglas fir-spruce and the white-pine types, totaling together nearly 4½ million cords, as well as that in the yellow-pine type reaching nearly 6 million cords, could be counted on. Possibly 1 million cords a year would not be unreasonable for pulp potentialities of the near future, and permanently thereafter.

PINE AND LARCH PULP WOOD.

The sulphate-pulp pines and larch in the Rocky Mountain region together total about 342 million cords, a much larger present volume than that of the spruce group. White pine, the most heavily cut species now, will be in even greater demand for lumber in the future, so that only relatively small amounts, if any, will probably be available for pulp wood. Yellow pine, with a present stand of more than 135 million cords, is being a little less heavily cut now than white pine, but is certain to increase in demand for both local and general lumber markets. There is the distinct possibility, however, in regions of extensive stands that thinnings and low-grade logs could be used economically for pulp in connection with lumbering. The total amount available would probably be relatively small. The stand of lodgepole, a species entirely suitable for sulphate and possibly also, because of its similarity to jack pine, for sulphite pulp, is only slightly less than that of yellow pine—about 130 million cords. Lodgepole is now less in demand in the Rocky Mountains than either western yellow or western white pine. From the standpoint of supplies alone there are undoubtedly opportunities in Montana, Wyoming, Utah, and Colorado for its immediate use for pulp. Its growth under intensive forestry, estimated at $4\frac{1}{3}$ million cords a year, should afford a permanent future supply. There is no apparent reason why the paper industry should not become one of the most important if not the major consumer of lodgepole pine. To the pines must be added larch, with a stand of 34 million cords.

The greatest possibility for sulphate pulp from the various species discussed is probably from lodgepole, with western yellow pine and larch second, and white pine a minor possibility; altogether they might supply from 1 to 2 million cords a year continuously.

CENTRAL STATES.

The forests of the Central States, except for relatively small stands of spruce and fir in West Virginia and Tennessee, the scattered hemlock in the same territory, and the northern extension of the southern-pine stands in Tennessee and Missouri, are made up of a wide variety of hardwood-pulp species. One-third, or about 240 million cords, of the total stand in the region consists of pulp species, and four-fifths of the pulp stand is composed of about 10 hardwood species suitable for soda pulp. (Table 63.) Half of the total hardwood stand consists of birch, beech, and maple. The opportunity is for an enlargement of the pulp-wood cut of hardwood for soda pulp.

The Central States now support a large number of paper mills, which manufacture chiefly book and boards, but they have few pulp mills. As in all eastern and most western forest regions, the forest is being heavily overcut, at about four times the rate of replacement by growth, and a large area now supports only scrub hardwood trees with far too little promise of high-grade products, such as lumber. Properly conducted operations in such forests could be made of material benefit by the removal of poorer and more defective trees, thinnings, etc. Out of this could come an immediate increase in the supply of pulp wood for soda pulp, and as the forests are gradually brought under management any such enlargement of the industry could be supported on a permanent basis. With properly directed cutting, such an enlargement of pulp and paper manufacture could be made to stimulate rather than retard the development of forest management.

Paper manufacture would be handicapped as now by having to ship in sulphite pulp from other regions. The amount which could be secured from the spruce-fir-hemlock stands of the western Appalachian Ranges would be small, and possibly unreliable for a permanent industry.

Potential growth under intensive forestry of the four or five types containing soda-pulp timbers is very large, reaching nearly 29½ million cords a year. Out of this total could unquestionably be secured soda pulp wood enough to meet all of our present deficit of 196,000 cords, and in addition enough to meet for an indefinite period to come the annual increase in our needs which now amount to 23,000 cords. Relatively small areas devoted exclusively to the growing of soda-pulp species would produce the entire amount of the present and greatly enlarged future requirements.

NATIONAL TIMBER GROWTH UNDER FOREST MANAGEMENT.

In some of the more critical types and regions, as for example the spruce-fir type in the Middle Atlantic States, the current pulp-wood demand alone would absorb all or more than the total estimated growth under intensive forest management. Intensive forestry on the entire area of the type would, therefore, be necessary to support an industry of the present size under present pulping processes. In other types and regions, however, the pulp and paper industry could meet its own requirements from relatively small areas of forest land intensively managed or from larger areas with a cruder system of forestry. The use of southern pines for sulphate pulp is a case in point. In either case pulp and paper concerns have the opportunity to secure and reforest land areas sufficient in size to meet their own supplies.

Regardless of whether either of these two or an intermediate condition obtains, however, the question of pulp-wood production and that of wood production for all other purposes upon the entire area of forest land, are so closely related that they can not be separated. The consideration of possible timber growth, therefore, affords a necessary background both from the standpoint of the public interest and that of the pulp and paper industry, for the solution of the whole pulp and paper problem.

POSSIBLE GROWTH UNDER CRUDE FOREST MANAGEMENT.

Forest lands in every timber region of the United States can be kept productve by simple, practical, and relatively inexpensive measures. On some lands thoroughgoing fire protection alone will assure a new crop, not necessarily of the best species in the least time, and almost certainly with reduced yields, but still timber crops. In other forest types such additional measures as the reservation of seed trees or of the smaller trees at the time of cutting will be necessary. Such measures as these constitute a preliminary step toward intensive forest management.

Under such simple measures, however, it is estimated that the present annual growth in the entire United States of 6 billion cubic feet could be increased by 1950 to 10 billion. Ten billion feet, however, falls far short of the 25 billion feet now taken from the forests or destroyed, and at the present rate of use, timber scarcity is making itself felt in other products than pulp, including such important products as lumber and ties.

Simple forestry measures, however, if continued for a long enough period, could be made still more productive. The effect of cumulative fire protection would be pronounced and the area containing growing stands of timber would be steadily increased, so that ultimately it is estimated under these methods growth on our 470 million acres of forest land might be increased to 14 billion cubic feet. Fourteen billion feet is better than ten, but the possibility of this annual growth is far in the future and is still only a little more than half of what we now destroy or use from the forest each year. A limitation to any such production would inevitably mean a most drastic reduction in timber use in the

United States, affecting lumber and practically every other forest product. Pulp wood, because of its competitive advantages, might be better off than most of the others.

POSSIBLE GROWTH UNDER INTENSIVE FOREST MANAGEMENT.

Intensive forest management, which would force our forest lands to their greatest effort, will require effective protection against fire; and methods of cutting the mature timber that insure prompt and complete reforestation. It will require the selection and concentration of growth on the best species in each region. It will require cultural operations such as thinnings, which alone can keep the stand at optimum growth and which in Europe yield, and in this country may be expected to yield, a revenue from forest land before the main crop reaches maturity. It will require a cut so regulated that no more than the equivalent of the current growth in the whole forest will be taken annually or periodically. It will require a grasp of technical methods of timber growing comparable with what has slowly been developed for producing timber crops in Europe, and for producing agricultural crops in the United States. To make the practice of intensive forestry universal, or even the rule, throughout the United States can at best be only a gradual process. Forest land can not be brought to its full growing power in a short time.

Based upon the best data that we now have on the growth of American trees and forest types, checked by European experience. it is estimated that our 470 million acres of forest land could ultimately be made to produce in the neighborhood of 27 billion cubic feet annually. (Table 47.) Such a yield leaves a fairly comfortable margin over the present annual cut of 22½ billion cubic feet, but a rather narrow margin when the increased present drain, estimated at 2½ billion cubic feet, from fires, insects, and disease is added. Intensive forest management, however, must strive to reduce this loss. The more successful such efforts are, the greater will be the margin between present requirements and possible ultimate timber growth, with corresponding leeway for increased utilization to supply our growing demands for pulp wood, lumber, and other products.

The margin between the present drain on our forests and the possible growth on our entire area of forest land under intensive forestry exceeds 22 million cords, and more than half of this total, or something over 12 million cords, is of pulp species. We now lose about 20 million cords of timber each year through fire, insect infestations, fungous diseases, and windfall, and more than half of this is pulp timber. To these possible amounts of wood that may become available in the continental United States, must be added 2 million cords a year to cover estimated growth in southern and southeastern Alaska. There is thus a possible total of 14 million cords, plus the 5 or 6 million cords additional which ought to be saved from fire, insects, and disease, to be drawn upon in providing for an increase of our pulp-wood cut from the present 4½ million cords to the objective of 15 million cords previously set. To what extent this timber will, if grown, be actually available for use by the pulp and paper industry will depend upon the amount and severity of competition by other industries for the same timber.

The possibility of using small timber from thinnings, thereby increasing timber growth, and of using the smaller and more defective logs in connection with operations requiring high-grade timber, should tend to make the solution of the problem much easier. Our greatest future difficulties will unquestionably be in supplying the high-grade material for such products as lumber, which requires a long growing period. It is fortunate that our resources are not limited to the possibilities of growing pulp wood on the basis of present manufacturing practices, which alone have been included in the estimates of possible pulp-wood cut in the regional discussions.

ESSENTIAL SUPPLEMENTARY MEASURES FOR MEETING REQUIREMENTS.

Increased use of logging and sawmill waste through closer correlation of the lumber and pulp industries, increased use of waste paper, and reduction of waste in pulp and paper manufacture afford possible ways to reduce the drain on the forest for our paper requirements. At the same time, a wider use of species would tend to distribute the problem of pulp-wood supply more widely and to make its solution easier.

UTILIZATION OF LOGGING AND SAWMILL WASTE AND INTEGRATION OF TIMBER-USING INDUSTRIES.

Census reports indicate that the use of logging and sawmill waste in pulp making is decreasing in the United States. The quantity thus utilized in 1922, about 88,000 cords, was only about one-third of that in 1909, the first year for which figures are available. (Table 5.) The decrease has accompanied rapidly increasing pulp-wood prices. There are probably a number of reasons for this unexpected falling off. Lumber manufacture in any one sawmill set or location has hitherto been largely temporary, and the pulp and paper industry has ordinarily come in near the close of the major lumbering operations. In fact, in New England and New York it has been hastening the exit of lumber manufacture. Probably, therefore, there has been greater and greater difficulty in securing sawmill waste. If European experience is a guide, another factor of importance is the organization in the United States of lumber and pulp and paper manufacture as separate industries having no relation to each other. The general result probably is that pulp manufacturers find it so troublesome and expensive to secure logging and sawmill waste from lumber companies that its use has gradually been discontinued.

It is shown in the article entitled "Timber: Mine or crop?" published in the 1922 Yearbook of the Department of Agriculture, that the waste in primary lumber manufacture in the United States amounts to approximately 5.13 billion cubic feet a year. Deducting the possible lumber saving through improved methods of manufacture and utilization, there would still remain unutilized an enormous volume of material, equivalent to more than 40 million cords a year. More than half of the present stand of timber in the United States is of species suitable for pulp, and the lumber cut of the pulp species is roughly in proportion. It is entirely out of the question to expect the utilization of any large proportion of this waste for years to come. But with the pressure of high pulp-wood prices, the insistent demands of a growing population for paper, the development of a more stable lumber industry based on a succession of forest crops, and the coordination, as in Sweden, of lumber and pulp utilization, it should in time be possible to utilize several million cords of waste a year.

In Sweden, for example, most of the large sawmills have box factories, planing mills, charcoal plants, and finally sulphite and sulphate pulp mills which operate partly on logging and sawmill waste and partly on logs which can not be sawed profitably into lumber. These groups of mills operate under single control, so that it is possible to divert logs from one product to another as conditions warrant. It is reported, in fact, that the entire Swedish pulp and paper industry, one of the most important in the world, operates incidentally to a forest management designed for saw-timber growing. No wood is cut primarily for the Swedish pulp mills. Thinnings are made to meet the requirements of the forests, and this, with poorer logs and sawmill waste, constitutes the entire supply of raw material for pulp.

This is the ideal arrangement, to which the correlation of the lumber and pulp industries in the United States should come in many regions. That it is feasible

even now is shown by large enterprises in the South and in the Lake States which combine lumber manufacture on a large scale with pulp and paper manufacture on an almost equally large scale. There is at least one concern in New England which follows the same plan to great advantage. Several of the pulp mills on the Pacific coast and many of the mills in the Lake States are dependent in part or altogether upon poorer logs cut during the lumber operations.

But we still have a very long way to go before we can approach the Swedish ideal. With a forest area of approximately 55 million acres, all of which lies above the northern limit of the United States proper, and with a timber growth still short of the full capacity of its soil, Sweden is able to produce annually about 3 million cords of pulp wood. On the same scale the United States, with its 470 million acres of forest land, and with a potential average production more than that of Sweden, should be able, as illustrated by Figure 29, to produce at least 26 million cords of pulp wood as an incident to lumber production, even though a much smaller proportion of our species are now regarded as suitable for pulp.

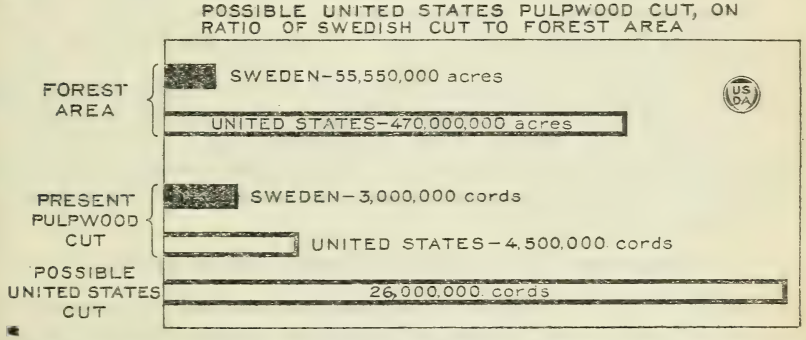


FIG. 29.—If Sweden can cut 3 million cords of pulp wood from 55 million acres of forest land annually, the United States, with forest management and balanced utilization, should be able to cut 26 million cords on the same ratio. The possibilities in the United States are even greater. Practically all of the Swedish species are suitable for pulp, while in the United States pulp species form only about 55 per cent of the present stand of timber. But average growth in Sweden is 24 cubic feet per acre, while that estimated for the United States is 58 cubic feet, more than twice as much.

INCREASED USE OF WASTE PAPER.

Reuse of waste paper, now about 85 per cent wood, reduces correspondingly the annual demand on the forests. American mills consumed a little less than 140,000 tons of waste paper in 1889, or about 12 per cent of the total volume of paper consumed that year. In the next 30 years the use of waste paper grew to nearly 1,855,000 tons, or about 29 per cent of the total volume of paper consumed.

One great obstacle to more extensive use has been the lack of a satisfactory de-inking process, but this obstacle has now been surmounted from a technical standpoint if not from that of actual commercial operation. The cost of collection and storage now limits reuse to large centers of population, but the possibilities in this direction are still far from exhausted. More general municipal collection and utilization of waste materials will tend to increase the amount of waste paper available, while higher prices will tend to make more and more feasible the use of this paper.

REDUCTION OF WASTES IN PULP AND PAPER MANUFACTURE.

Investigations have shown that decay causes a large waste in both pulp wood and pulp storage. Pulp wood stored under unfavorable conditions for two or three years has been found in some cases to yield 25 per cent less pulp than the

same kind of wood pulped when green. Even where wood was stored for a period of only one year pulp yields were one-seventh less than from the same kind of wood pulped when green. Likewise many cases were recorded where the actual cellulose content of pulp was reduced 5 to 10 per cent by storage under conditions favorable for decay. From these studies it was estimated that the total annual loss on mechanical pulp from decay while in storage is equivalent to approximately 200,000 cords and that the loss of pulp wood in storage is 400,000 cords. The paper made from infected pulp was unsatisfactory in appearance and had half or less than half the bursting and tensile strength shown by paper from sound pulp. Storage losses from decay in both cases are due to improper methods and are, therefore, preventable in large part. Pulp-wood loss may be largely eliminated by keeping wood yards free from infected wood and bark, and by using the wood in rotation so that none is allowed to remain in the yard over a year. Losses of stored pulp from decay may be prevented by the use of preservatives.

A further and very large loss occurs in the manufacture of chemical pulp, where on the average only approximately 45 per cent of the original weight of the wood is secured in pulp. The remainder is lost in the cooking liquors. Much time and money have been spent in research designed to eliminate these losses. Some hopeful results have been secured. For example, by proper cooking operations and methods of control, as demonstrated by both laboratory and mill tests, it is possible to increase the output of sulphite pulp from the same amount of wood by 10 per cent. This can be accomplished through minor modifications of the sulphite process now in general use. Any possible increase in pulp yield will obviously reduce correspondingly the amount of wood required for a specified volume of pulp or paper.

MODIFIED PULPING PROCESSES AND WIDER USE OF SPECIES.

The number of species which have been regarded as suitable for pulp making has gradually increased, under pressure of high prices because of timber shortage, and as a result of scientific investigations into the pulp-making properties of different woods and into the pulping processes. A new or modified pulping process which would enable pulp from such woods as beech, birch, maple, and aspen to compete with mechanical pulp would revolutionize the situation in northern New England and would greatly relieve the crisis even in New York. It would go a long way at least toward saving the present newsprint industry in these and other States, by affording time to get greatly increased timber growth under way. A process which increased the number of suitable species for sulphite or mechanical pulp, in particular, would be of great value in the solution of our entire future pulp-supply problem.

A series of investigations covering the pulp processses and the suitability of American woods for pulp has been under way in the Forest Service for a good many years. Preliminary results in one of these investigations justify comment. The wood in this experiment is chipped in the normal manner for chemical pulp; the chips are slightly but uniformly softened by chemical treatment and are then mechanically disintegrated. The high yields of 75 or 80 per cent of the original weight of the wood, the low cost of the chemical treatment, and the low power requirements indicate the possibility, in some of the results very recently obtained with hardwoods and pines, that a very satisfactory pulp can be made at a total cost comparable with mechanical pulp.

Spruce typifies the rigid requirements of the mechanical process, but the successful completion of this investigation would permit the substitution in mechanical pulp and hence in newsprint of woods of lower qualities which are now considered valueless for this purpose. The newsprint mills which experience difficulty in securing spruce and fir pulp wood might be able to turn to the local

domestic hardwoods at least during the stringent period of readjustment while growth of the softwood forests is being brought to a maximum. The greater the spruce shortage the greater will be the incentive to turn to this process or to develop one which would accomplish the same purpose. The Forest Service process promises also to make pulp from pine available as a substitute for sulphite. It might also, therefore, with its low power requirements, open up new regions of the United States, like the southern pineries, as potential areas for the development of the newsprint industry.

Whether this particular investigation works out commercially in accordance with the promise of laboratory tests or not, it at least serves as an indication of the possibilities of new or modified pulp processes. This indication and the critical need of the industry are ample justification for a large amount of research having the same objective. Some such development may well be the chief means of offsetting any pulp-wood deficit to our present industry until increased amounts can be grown.

Forest Service investigations have further shown the possibility of substituting bleached sulphate pulp made from the pines for bleached sulphite pulp made from spruce. The process is now in commercial use and more general use is possible. Unbleached sulphate pulp could replace much of the unbleached sulphite pulp now used in wrapping papers and boards. Potentially over 1 million cords of spruce could be released by such replacements.

For obvious reasons it is impossible to give a concrete sum total of how much this varied group of essential supplementary measures might at any future time decrease the demand on the forest for pulp wood under present manufacturing requirements, or how much additional pulp wood they might supply. But it is clear that in time the total could easily reach several million cords a year. In that case with forest management as a foundation it will easily be possible to supply from domestic materials all the future paper requirements of the United States.

CONCLUSION.

OUTSTANDING FINDINGS.

The outstanding findings of this inquiry into the pulp and paper situation are that:

The question of adequate present and future pulp-wood supplies is an important phase of the national timber supply problem, which is one of the most important problems now demanding solution in the United States.

There are outstanding reasons for creating a permanent domestic pulp and paper industry which can meet our entire needs, founded on home-grown timber. In the long run this will insure cheaper products to the ultimate consumer than can be obtained from foreign countries. The high productive capacity of our forest soils, and abundant supplies of other materials than wood essential in pulp and paper manufacture, should make cheaper products entirely feasible.

American paper requirements have nearly quadrupled since 1899 and now exceed 8 million tons a year. They constituted 56 per cent of the world's paper consumption in 1920. Our per capita consumption is double that of any other country.

The enormous growth of paper production and consumption during the past half century has been based upon wood, of which the amount now used exceeds several times that of all other materials together. The paper now consumed in the United States requires 9,148,000 cords of wood. All available information indicates that the supremacy of wood as the chief pulp material will continue.

American forests now supply only 49 per cent of the pulp wood required in our paper consumption, whereas as recently as 1899 they supplied 83 per cent. The increase in imports since 1910 has been almost entirely in pulp and paper.

Pulp-wood imports, although of great importance, now constitute only 19 per cent of the pulp wood consumed in American mills and only 11 per cent of that required for all the paper we consume. Paper and pulp imports constitute an equivalent of 42 per cent of the pulp wood needed for our entire paper requirements. About half of the pulp-wood imports are used for sulphite, three-tenths for mechanical, and the remainder for soda pulps. Newsprint, book, and wrapping papers absorb one-third, one-fourth, and one-eighth, respectively.

American forests supply less than half of the pulp wood needed for all the sulphite, mechanical, and sulphate pulp we use, but four-fifths of that needed for soda pulp. Of what is needed for newsprint paper they furnish only one-third, of that for wrapping paper two-thirds, and of that for boards and book paper slightly more than half.

Canada furnishes the pulp wood for 37 per cent of our entire paper requirements, and about equally in the form of pulp wood, pulp, and paper. Thirty-seven per cent of our entire newsprint requirements are imported from Canada as paper—more than the amount of newsprint manufactured from domestic wood. Countries other than Canada supply 17 per cent of the pulp wood needed to meet our entire paper requirements, but four-fifths of this material is imported in pulp form.

Seventy-eight per cent of the pulp wood now required consists of spruce, fir, and hemlock for sulphite and mechanical pulp, 14 per cent is pine for sulphate pulp, and the remainder is hardwoods for soda pulp. In part out of this concentration in requirements has come a concentration of the pulp and paper industry in the spruce, fir, and hemlock forests of the Middle Atlantic, New England, and Lake States. The inability of the forests of these regions to meet the demands of the pulp mills has led to imports of Canadian pulp wood, 85 per cent spruce and the remainder aspen. The Middle Atlantic States use 73 per cent of the total imports and New York alone uses 57 per cent; 21 per cent is used in New England; and the rest goes to the Lake States.

The forests of practically every region in the United States are being cut much more rapidly than they are being replaced by growth, and in most regions the original timber supplies have been greatly reduced. The regions from which pulp-wood supplies are now being chiefly secured fall within the latter class. This situation is the background of the problem of increasing the domestic pulp wood cut sufficiently to meet our requirements.

THE PROBLEM.

The most urgent phase of the pulp and paper problem of the immediate future is to secure annually an additional 870,000 cords of spruce, hemlock, and balsam, and 180,000 cords of aspen pulp wood from our own forests, to offset pulp-wood imports. Purely economic causes make this problem urgent, regardless of any other considerations or possible developments. Closely related to the pulp-wood import problem, and only a little less urgent, is the growing shortage of pulp timber in nearly all of the Middle Atlantic, New England, and Lake States, which in itself must be faced and met in the near future. The distribution of pulp-wood imports chiefly to the Middle Atlantic States, particularly New York, and in lesser amounts to New England and the Lake States, is in itself an indication of the present shortage of local timber supplies.

An important but less urgent phase of the problem is to secure from American forests the pulp wood required to offset present pulp and paper imports. Including the amounts indicated in the preceding paragraph, this would require a total

increase in the spruce, fir-hemlock cut of about 3,916,000 cords annually, in the pine-pulp-wood cut of 773,000 cords, and in the cut of various hardwoods of 196,000 cords.

The third phase of the problem is to meet increasing future paper requirements from our own forests if possible. This, based upon the increase in requirements of the past decade or two, would necessitate a further increase in the spruce-fir-hemlock pulp-wood cut of 237,000 cords a year, in the pine cut of 110,000, and in the hardwood cut of 23,000 cords. Upon the basis of possible paper consumption of 13½ million tons by approximately 1950, there would be required at that time, under present manufacturing practices, nearly 12 million cords a year of spruce, fir, and hemlock pulp wood, 2 million cords of pine, and a little over 1 million cords of hardwood, or a total of about 15 million cords.

THE SOLUTION.

ESSENTIAL SUPPLEMENTARY MEASURES.

One possibility of making less difficult the solution of the three phases of the general pulp-wood supply problem is through new or modified pulping processes to increase the number of species available for pulp, and particularly for sulphite and mechanical pulp: If such an increase can include species which still remain in comparative abundance in the Middle Atlantic, New England, and Lake States, it will be of the first importance in relieving the present crisis.

Some relief can be secured in the spruce-fir-hemlock problem by shifting sulphate-pulp production more largely or altogether to pine or larch. Bleached sulphate pulp can also be substituted to a much greater extent for bleached sulphite pulp in book and similar papers, with corresponding reduction in spruce, fir, and hemlock requirements. Similarly, unbleached sulphate can be substituted for the sulphite in boards and wrapping paper.

It should also be possible to reduce the pulping waste in the chemical processes, where now in general only about 45 per cent of the original weight of the wood appears as pulp, and to reduce present pulp-wood and pulp losses from decay. The reuse of waste paper has grown to 29 per cent of our total paper consumption; but, if need be, it can be made to furnish to new paper much more than its present contribution of 1,850,000 tons a year.

The use of woods and sawmill waste in pulp and paper making has actually decreased during the past 15 years, despite rapidly increasing pulp-wood prices. About 20 million cords a year of the sawmill waste in species suitable for pulp can not be saved in lumber manufacture. Even with a great reduction in lumber cut and large allowance for the mills from which waste can not be secured, anything approaching the Swedish plan of integrated lumber and pulp industries would permit a vast increase in the utilization of waste over our 1922 total of less than 90,000 cords. Ultimately, with such an organization of industries and utilization as in Sweden, we could nearly double our 15 million cord pulp-wood objective without reducing saw-timber production.

GROWING PULP WOOD THE FUNDAMENTAL SOLUTION.

All of these measures have a distinct and important place in the solution of our pulp and paper problem, and full advantage must be taken of them. Through some of them immediate results can possibly be secured to relieve critical situations. The main reliance in ultimately and fully meeting our pulp-wood requirements must, however, be placed upon the growing of timber. The possible margin of growth on our present area of forest land, under intensive forest management, over the present drain, would ultimately amount to about 12 million cords of the pulp species. To this could be added the part of about 11 million

cords of pulp species, now lost annually by fire and disease, which it is possible to save under better protection. To both could be added also 2 million cords annually from Alaska. Out of this total could be met the $10\frac{1}{2}$ million cord difference between the present cut from our forests and an ultimate cut of 15 million cords of pulp wood, and leave a substantial difference for increased use of other wood products. The chief difficulty would arise out of a continued concentration of requirements on the spruces, firs, and hemlocks.

In some regions all of the growth on the types now supporting pulp species would be required to maintain an industry of the size of that already in existence. In others there would be a large leeway between pulp requirements and the total possible growth, so that intensive forestry on smaller areas would meet pulpwood demands.

THE SOLUTION OF THE IMMEDIATE SPRUCE-FIR-HEMLOCK PROBLEM.

Unfortunately the timber supplies of New York and Pennsylvania are now so greatly reduced, in relation to demands, and provisions for their replacement by growing new supplies are still so far short of ultimate possibilities, that a curtailment of pulp production seems to be the only outlook if present pulping processes are continued. How rapid the curtailment will be, and how far it will go, depends primarily upon how soon forest management is applied, with what degree of intensity, and on what part of the area of the entire spruce-fir type. Increased cutting of pulp timber in the immediate future would merely hasten and aggravate later curtailment. While taking full advantage of the supplementary measures already outlined, the main effort in the solution of the problem in the Middle Atlantic States must therefore be to increase timber growth.

The outlook of the immediate future in New England is similar, but less critical because of the larger timber supplies in relation to plant requirements and the smaller pulp-wood imports. New Hampshire, of the three spruce States, is in the worst situation, and Vermont in the best. Vermont might succeed in supplying its own mills, but will probably be called upon increasingly to assist New Hampshire and New York. Drastic curtailment is the only outlook for New Hampshire so far as its own supplies are concerned, and reliance upon Maine and Vermont serves only to aggravate the difficulties of these States. Full advantage must be taken of supplementary measures; but the main solution in New England, as in the Middle Atlantic States, lies in the promptness, extent, and intensity of forest management on the entire spruce-fir type.

Michigan's spruce and hemlock supplies are chiefly available for Wisconsin. Wisconsin, with only limited resources of its own, draws its pulp wood largely from Michigan and Minnesota. Minnesota, with anything but a favorable spruce outlook, is trying to eliminate the competition of Wisconsin mills. Eliminating new processes, the only way in which the pulp industry can hold its own in the near future is through increased use of hemlock in competition with the sawmills, and through the possibility, already beginning in fact, of using jack pine. Both of these species are more suitable for sulphite than for mechanical pulp. Both, without intensive forest management, and possibly hemlock in any case, will be purely temporary expedients. Immediate enlargement of the pulp-wood cut or of the manufacturing industry is out of the question without corresponding curtailment later.

Under present pulping processes, therefore, new regions alone, with ample stocks of virgin timber, offer the only hope of making up in the near future either our 870,000 cords of spruce-pulp wood imports or the sum total of our dependence for spruce, fir, and hemlock pulp wood, equivalent to 3,916,000 cords. Half of the latter can be wiped out by a new industry in Alaska; three-fourths can be secured from the forests of Washington, Oregon, and California; one-fourth can

be secured from the Rocky Mountain forests in Montana and Idaho. New and enlarged regional industries should avoid the mistakes shown by past experience and develop upon a conception of permanent operation rather than for a restricted period. Only the growing of new crops of timber to replace present supplies can afford a basis for permanent plant operation.

THE SOLUTION OF THE FUTURE SPRUCE-FIR-HEMLOCK PROBLEM.

On the basis of present utilization, 78 per cent, or nearly 12 million cords of a future 15 million-cord pulp-wood objective, must consist of the spruces, true firs, and hemlocks. The possible cut from Alaska, the Pacific coast, and the northern Rocky Mountain States, including the present pulp-wood cut, is placed at about 6⅓ million cords annually. Allowance is made for use by other industries. This is conditional upon intensive forest management on all cut-over lands, or at least on restricted areas devoted to pulp-wood production.

Potential growth on the spruce-fir lands of the Middle Atlantic, New England, and Lake States combined can ultimately, under similar methods, exceed 6 million cords. The use of spruce for other purposes than pulp wood might perhaps be offset by the utilization of more or less jack pine, and possibly also hemlock, for sulphite pulp, and by the further possibility of cutting spruce and hemlock in the southern Appalachians. The total for the East and West would barely meet a 12-million-cord requirement, and the eastern contribution would not be available until long after 1950.

THE SOLUTION OF THE PINE AND HARDWOOD PROBLEMS.

Soda-pulp-wood imports of 180,000 cords and the total dependence of 196,000 cords could, if necessary, be offset in the immediate future by increasing the cut of the aspen, beech, birch, and maple forests in the New England and Middle Atlantic States. Probably the entire volume could be secured in either the Lake or the Central or the Southern States. Together these groups of States could in the immediate future, and permanently under forest management, supply requirements up to an objective of a little more than 1 million cords out of the total of 15 million, and a great deal more, if necessary. Only a relatively small part of the total area of forest land in these regions would, in fact, be necessary under forest management to meet all future requirements for soda pulp.

Similarly, the solution of the sulphate-pulp-wood problem is relatively easy. The 2,000-cord pulp-wood import is insignificant. The entire dependence of 773,000 cords could be made up altogether and the annual increase absorbed for years to come under forest management in the South alone, but the Pacific Coast, Rocky Mountain, and Lake States can also be drawn upon. Here again a relatively small part of the total forest area could under forest management produce the entire sulphate-pulp-wood requirements.

THE SHARE OF THE PUBLIC AND OF THE INDUSTRY IN THE SOLUTION.

Public interest in the pulp and paper problem carries public responsibility to aid in its solution. The supplies of pulp wood, lumber, and other forest products and the profitable utilization of our forest land constitute merely two phases of one of our most important national problems. The public is interested in securing permanent as contrasted with temporary industries. It is interested also in securing ample future supplies of paper at reasonable prices.

The public must redeem its responsibility by enlarging the area of publicly owned forest lands and devoting such lands in part to the growing of pulp wood.

In cooperation with private owners it must extend and improve protection against fire, insects, and disease. It must solve the question of forest taxation, which in its present form helps to discourage efforts by private owners to grow their own timber supplies. It must encourage the development of satisfactory forms of timber insurance. It must aid in forest-products research into pulp woods and pulping processes. To supplement present knowledge, it must, in cooperation with the pulp and paper industry, extend and enlarge the research of forest experiment stations in methods of reforestation, timber growing, and protection. It must also secure fuller data on the adjustment of needs and supplies. Although the general information available amply justifies action along the lines suggested, much more accurate and detailed data on timber supplies, growth, requirements, and available forest lands are essential for thoroughly satisfactory plans from the standpoint of either the pulp and paper industry or the public. For such data reliance can be placed only upon a timber survey, and in making this the public and the industry must cooperate.

The interest of the industry in planning and providing for itself ample supplies of raw materials to meet its own future requirements is still more immediate and direct than that of the public and carries corresponding responsibility for the solution of the pulp and paper problem.

The responsibility of the industry extends to cooperation in the lines indicated—forest protection, forest-products investigations, research at forest experiment stations, and a thoroughgoing timber survey. It includes systematic and widespread efforts to apply the results of research as rapidly as they become available. Further than all of these, the pulp and paper industry should, to safeguard its own interest, assume the leadership in timber growing on its own forest lands and those upon which it is dependent for pulp-wood supplies. The alternative of scrapping pulp and paper plants or diverting them to other and less essential products affords no real choice.

APPENDIX.

TABLE 1.—*Paper consumption of the United States and the wood pulp and pulp wood required in its manufacture.*

[Quantities in tons of 2,000 pounds and cords of 128 cubic feet.]

Year.	Paper.	Wood pulp.	Pulp wood.	Year.	Paper.	Wood pulp.	Pulp wood.
	Tons.	*Tons.*	*Cords.*		*Tons.*	*Tons.*	*Cords.*
1922	8,003,000	5,847,000	9,148,000	1889	1,121,000		
1921	6,054,000	4,345,000	6,649,000	1879	457,000		
1920	7,861,000	5,315,000	8,300,000	1869	391,000		
1919	6,493,000	4,497,000	6,806,000	1859	[1] 127,000		
1918	6,387,000	4,270,000	6,366,000	1849	[1] 78,000		
1917	6,256,000	4,467,000	6,783,000	1839	[1] 38,000		
1914	5,496,000	3,798,000	5,886,000	1829			
1909	4,224,000	2,753,000	4,420,000	1819	[1] 12,000		
1904	3,050,000	2,062,000	3,259,000	1810	[1] 3,000		
1899	2,158,000	1,147,000	1,950,000				

[1] United States production; value of exports and imports are approximately equal.

TABLE 2.—*Raw materials consumed in United States paper manufacture.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Bureau of the Census.]

Year.	Wood pulp.	Rags.	Waste paper.	Manila stock.	Straw.	All other.
1919	4,019,696	277,849	1,854,386	116,994	353,399	106,850
1914	3,490,123	361,667	1,509,981	121,170	307,839	97,276
1909	2,826,591	357,470	983,882	117,080	303,137	29,422
1904	2,018,764	294,552	588,543	107,029	304,585	
1899	1,172,880	234,514	356,193	99,301	367,305	
1889	349,917	246,892	139,061	524,862	355,131	
1879	[1] 22,570	200,005	87,840	84,786	245,838	1,218

[1] Production; exports and imports, not reported, are assumed to be equal.

TABLE 3.—*Paper consumption of the United States.*[1]

[Quantities in tons of 2,000 pounds.]

Year.	Total.	Newsprint.		Book.		Boards.		Wrapping.		Fine.		All other.	
	Tons.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.
1922	8,003,000	2,451,000	31	968,000	12	2,154,000	27	1,059,000	13	356,000	4	1,015,000	13
1921	6,054,000	2,002,000	33	707,000	11	1,641,000	27	770,000	13	230,000	4	704,000	12
1920	7,861,000	2,196,000	28	1,060,000	13	2,301,000	29	1,003,000	13	371,000	5	930,000	12
1919	6,493,000	1,892,000	29	838,000	13	1,940,000	30	825,000	13	306,000	5	692,000	10
1918	6,387,000	1,760,000	28	800,000	13	1,927,000	30	859,000	13	348,000	5	693,000	11
1917	6,256,000	1,824,000	29	846,000	14	1,805,000	29	814,000	13	276,000	4	691,000	11
1914	5,496,000	1,576,000	29	926,000	17	1,292,000	24	892,000	16	244,000	4	566,000	10
1909	4,224,000	1,159,000	27	689,000	16	883,000	21	763,000	18	193,000	5	537,000	13
1904	3,050,000	883,000	29	495,000	16	521,000	17	644,000	21	142,000	5	365,000	12
1899	2,158,000	569,000	26	314,000	15	394,000	18	535,000	25	113,000	5	233,000	11
1889	1,121,000												
1879	457,000												
1869	391,000												
1859	[2] 127,000												
1849	[2] 78,000												
1839	[2] 38,000												
1829													
1819	[2] 12,000												
1810	[2] 3,000												

[1] Imports added to United States production and domestic exports deducted.
[2] United States production, value of exports and imports approximately equal.

TABLE 4.—*Paper and wood pulp manufactured and pulp wood cut in the United States.*

[Quantity in tons of 2,000 pounds and cords of 128 cubic feet. Calendar year. Source, Bureau of the Census, Federal Trade Commission, and Forest Service.]

Year.	Paper.	Wood pulp.	Pulp wood.	Year.	Paper.	Wood pulp.	Pulp wood.
	Tons.	*Tons.*	*Cords.*		*Tons.*	*Tons.*	*Cords.*
1922	7,017,800	3,521,644	4,498,808	1905		[1] 2,084,482	2,546,695
1921	5,356,317	2,875,601	3,740,406	1904	3,106,696	1,921,768	2,477,099
1920	7,334,614	3,821,704	5,014,513	1899	2,167,593	1,179,525	1,617,093
1919	6,190,361	3,517,952	4,445,817	1889	934,611	305,544	583,200
1918	6,051,523	3,313,861	4,506,276	1879	452,107	22,570	41,000
1917	5,919,647	3,509,939	4,706,327	1869	[2] 386,000	1,077	2,200
1916		3,435,001	4,444,565	1859	126,889		
1914	5,270,047	2,893,150	3,641,063	1849	[2] 78,000		
1911		2,686,134	3,390,382	1839	[2] 38,000		
1910		2,533,976	3,146,540	1829			
1909	4,216,708	2,495,523	3,207,653	1819	[2] 12,500		
1908		2,118,947	2,651,817	1810	[2] 3,000		
1907		2,547,879	3,037,287				
1906		[1] 2,327,844	2,922,304				

[1] Estimated quantity of pulp produced.
[2] Estimated from values reported by the Bureau of the Census.

TABLE 5.—*Pulp-wood consumption of the United States.*

[Quantity in cords of 128 cubic feet. Source, Bureau of the Census and the Forest Service.]

Year.	Grand total.	Total domestic.	Total imported.	Spruce.		Poplar.	
				Domestic.	Imported.[1]	Domestic.	Imported.
1922	5,548,842	4,498,808	1,050,034	2,162,848	870,042	157,939	179,992
1921	4,557,179	3,740,406	816,773	1,813,762	701,131	131,038	115,642
1920	6,114,072	5,014,513	1,099,559	2,565,787	921,811	189,946	177,748
1919	5,477,832	4,445,817	1,032,015	2,313,419	873,795	180,160	158,220
1918	5,250,794	4,506,276	744,518	2,204,143	666,164	210,849	78,354
1917	5,480,075	4,706,327	773,748	2,385,966	681,450	313,955	92,298
1916	5,228,558	4,444,565	783,993	2,399,993	701,667	329,370	82,326
1914	4,470,763	3,641,063	829,700	1,892,739	768,056	328,513	61,644
1911	4,328,052	3,390,382	937,670	1,612,355	903,375	333,929	34,295
1910	4,094,306	3,146,540	947,766	1,473,542	902,407	315,717	45,359
1909	4,001,607	3,207,653	793,954	1,653,249	768,332	302,876	25,622
1908	3,346,953	2,651,817	695,136	1,487,356	672,483	279,564	22,653
1907	3,962,660	3,037,287	925,373	1,795,278	905,575	352,142	19,798
1906	3,661,176	2,922,304	738,872	1,785,680	721,322	310,920	17,550
1905	3,192,223	2,546,795	645,428	1,650,709	622,545	299,175	22,883
1904	3,050,717	2,477,099	573,618	1,732,531	538,305	213,058	35,313
1899	1,986,310	1,617,093	369,217	1,160,118	349,084	236,820	20,133
1889	583,200						
1879	41,000						
1869	2,200						

Year.	Hemlock.	Pines.	Balsam fir.	All other.	Slabs and mill waste.
1922	893,195	422,724	308,261	466,123	87,718
1921	863,043	282,375	226,726	356,445	67,017
1920	885,485	365,688	328,882	508,496	170,229
1919	795,154	293,610	288,814	399,579	175,081
1918	836,406	296,081	368,117	436,077	154,603
1917	775,003	221,038	382,036	394,347	233,982
1916	760,226	172,923	301,032	280,177	200,844
1914	602,754	141,359	125,296	296,515	253,887
1911	616,663	124,019	191,779	231,103	280,534
1910	610,478	105,882	132,362	245,922	262,637
1909	559,657	90,885	95,366	256,643	248,977
1908	569,173	84,189	45,309	186,226	[3]
1907	576,154	78,583	43,884	191,246	[3]
1906	528,381	69,277	33,886	194,160	[3]
1905	375,422	57,399	56,744	107,246	[3]
1904	[3]	[3]	[3]	531,510	[3]
1899	[3]	[3]	[3]	220,155	[3]
1889					
1879					
1869					

[1] Includes imported balsam fir. [2] Distributed according to species. [3] No data available.

TABLE 6.—*Wood-pulp production of the United States.*

[Quantity in tons of 2,000 pounds. Source, Bureau of the Census and the Forest Service.]

Year.	Total.	Mechanical.		Sulphite.		Soda.		Sulphate.	
	Tons.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
1922	3,521,644	1,483,787	42	1,374,319	39	419,857	12	243,681	7
1921	[1] 2,875,601	[1] 1,267,382	44	[1] 1,166,926	41	[1] 300,533	10	[1] 140,760	5
1920	3,821,704	1,583,914	41	1,585,834	42	463,305	12	188,651	5
1919	[2] 3,517,952	1,518,829	[2] 43	1,419,829	40	411,693	12	120,378	4
1918	3,313,861	1,364,504	41	1,456,633	44	350,362	11	142,362	4
1917	3,509,939	1,535,953	44	1,451,757	41	437,430	13	84,799	2
1916	3,435,001	1,508,139	44	1,466,402	43	387,021	11	73,439	2
1914	[3] 2,893,150	1,293,661	45	1,151,327	39	347,928	12	52,641	2
1911	2,686,134	[4]	------	[4]	------	[4]	------	------	------
1910	2,533,976	[4]	------	[4]	------	[4]	------	------	------
1909	2,495,523	1,179,266	47	1,017,631	41	298,626	12	------	------
1908	2,118,947	[4]	------	[4]	------	[4]	------	------	------
1907	2,547,879	[4]	------	[4]	------	[4]	------	------	------
1904	1,921,768	968,976	51	756,022	39	196,770	10	------	------
1899	1,179,525	586,374	50	416,037	35	177,114	15	------	------
1889	305,544	[4]	------	------	------	[4]	------	------	------
1879	22,570	[4]	------	[4]	------	[4]	------	------	------
1869	1,077	[4]	------	[4]	------	[4]	------	------	------

[1] Includes screenings.
[2] Includes screenings; mechanical, 12,220 tons; and chemical, not shown by process, 35,003 tons; combined equal to 1.3 per cent of total.
[3] Includes screenings; mechanical, 11,769 tons, and chemical, not shown by process, 35,824 tons; combined equal to 1.6 per cent of total.
[4] Not reported separately.

TABLE 7.—*Wood-pulp consumption of the United States.*[1]

[Quantity in tons of 2,000 pounds.]

Year.	Total.	Mechanical.		Sulphite.		Soda.		Sulphate.	
	Tons.	Tons.	Per cent.	Tons.	Per cent.	Tons	Per cent.	Tons.	Per cent.
1922	4,756,000	1,699,000	36	2,066,000	43	417,000	9	574,000	12
1921	3,544,000	1,458,000	41	1,471,000	42	296,000	8	319,000	9
1920	4,696,000	1,817,000	39	2,032,000	43	459,000	10	388,000	8
1919	[2] 4,114,000	1,733,000	42	1,669,000	41	406,000	10	271,000	7
1918	3,870,000	1,550,000	40	1,708,000	44	347,000	9	265,000	7
1917	4,149,000	1,815,000	44	1,708,000	41	432,000	10	194,000	5
1916	4,079,000	1,771,000	44	1,747,000	43	381,000	9	180,000	4
1914	[3] 3,557,000	1,523,000	43	1,524,000	43	346,000	10	128,000	4
1911	3,239,000	[4]	------	[4]	------	[4]	------	[4]	------
1910	3,032,000	[4]	------	[4]	------	[4]	------	[4]	------
1909	2,854,000	1,322,000	47	1,235,000	43	297,000	10	------	------
1908	2,358,000	[4]	------	[4]	------	[4]	------	[4]	------
1907	2,832,000	[4]	------	[4]	------	[4]	------	[4]	------
1904	2,091,000	[5]	------	[5]	------	[5]	------	[5]	------
1899	1,234,000	[5]	------	[5]	------	[5]	------	[5]	------
1889	350,000	225,000	64	53,000	15	72,000	21	------	------

[1] Data secured by adding imports to production and deducting exports.
[2] Includes 35,000 tons chemical screenings, not shown by process.
[3] Includes 36,000 tons chemical screenings, not shown by process.
[4] Production of pulp not reported by grades or process.
[5] Imports not segregated as to kind of pulp.

TABLE 8.—*Regional development of the pulp and paper industry of the United States in 1921.*

[Quantity in tons of 2,000 pounds and cords of 128 cubic feet. Source, Bureau of the Census and the Forest Service.]

Region.	Pulp-wood consumption.						Wood-pulp production.						Paper production.	
	Total.		Domestic.		Imported.		Total.		From domestic pulp wood.		From imported pulp wood.			
	Cords.	Per cent.	Cords.	Per cent.	Cords.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
United States	4,557,179	100	3,740,406	100	816,773	100	2,875,601	100	2,304,047	100	571,554	100	5,443,057	100
New England	1,345,709	30	1,060,785	29	284,924	35	927,135	32	731,146	33	195,989	34	1,342,159	24
Maine	1,005,158	22	819,025	22	186,133	23	710,329	25	573,860	25	136,469	24	656,144	12
New Hampshire	258,206	6	171,527	5	86,679	11	152,797	5	101,480	5	51,317	9	149,442	3
Vermont	47,471	1	44,755	1	2,716	.....	41,945	1	39,686	2	2,259	.....	57,652	1
Massachusetts	34,874	1	25,478	1	9,396	1	22,064	1	16,120	1	5,944	1	347,253	6
Rhode Island	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14,736	.....
Connecticut	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	116,932	2
Middle Atlantic	1,107,654	24	628,117	16	479,537	59	774,179	27	427,516	18	346,663	61	1,554,533	29
New York	781,168	17	393,482	10	387,686	48	606,869	21	305,263	13	301,606	53	920,453	17
Pennsylvania	326,486	7	234,635	6	91,851	11	167,310	6	122,253	5	45,057	8	423,431	8
New Jersey	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	210,649	4
Lake	1,218,274	27	1,168,074	31	50,200	6	709,967	25	682,028	30	27,939	5	1,188,111	22
Michigan	186,532	4	151,435	4	35,097	4	103,532	4	84,220	4	19,312	3	483,593	9
Minnesota	164,547	4	164,547	4	.....	.....	117,934	4	117,934	5	.....	.....	143,040	3
Wisconsin	867,195	19	852,092	23	15,103	2	488,501	17	479,874	21	8,627	2	561,478	10
Central	61,282	1	61,282	2	.....	.....	27,623	1	27,623	1	.....	.....	413,899	8
West Virginia	61,282	1	61,282	2	.....	.....	27,623	1	27,623	1	.....	.....	23,455	1
Indiana	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	175,003	3
Illinois	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	203,014	4
Iowa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12,427	.....
Pacific coast	342,560	7	342,560	9	.....	.....	219,655	7	219,655	9	.....	.....	281,493	5
Washington	149,691	3	149,691	4	.....	.....	95,161	3	95,161	4	.....	.....	108,273	2
Oregon	192,869	4	192,869	5	.....	.....	124,494	4	124,494	5	.....	.....	108,630	2
California													64,590	1
All other States	481,700	11	479,588	13	2,112	.....	217,042	8	216,079	9	963	.....	662,862	12

TABLE 9.—*Paper production of the United States.*

[Quantity in tons of 2,000 pounds. Source, Bureau of the Census, prior to 1917; Federal Trade Commission, 1917–1922.]

Year.	Total.	Newsprint.		Book.		Boards.		Wrapping.		Fine.		All other.	
	Tons.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.
1922	7,017,800	1,447,688	21	981,919	14	2,156,113	31	1,048,393	15	361,050	5	1,022,637	14
1921	5,356,317	1,226,189	23	725,992	14	1,664,931	31	782,468	15	242,485	4	714,252	13
1920	7,334,614	1,511,968	21	1,104,464	15	2,313,449	32	1,043,812	14	389,322	5	971,599	13
1919	6,190,361	1,374,517	22	914,823	14	1,950,037	32	869,631	14	343,762	6	737,591	12
1918	6,051,523	1,260,285	21	849,157	14	1,926,986	32	891,362	15	368,012	6	755,721	12
1917	5,919,647	1,359,012	23	892,283	15	1,804,589	31	844,229	14	288,355	5	731,179	12
1914	5,270,047	1,321,167	25	934,979	17	1,291,805	25	881,799	17	247,728	5	592,569	11
1909	4,216,708	1,175,554	28	694,905	16	883,088	21	763,067	18	198,213	5	501,881	12
1904	3,106,696	912,822	29	515,547	17	520,651	17	644,291	21	146,832	5	366,553	11
1899	2,167,593	569,212	26	323,208	15	394,111	18	535,252	25	112,707	5	233,103	11
1889	934,611	196,053	18	150,886	14	149,901	14	276,973	25	69,199	6	91,599	23
1879	452,107	[2] 149,177	33	----------	----	20,014	4	134,294	30	32,937	7	115,685	26
1869	[1] 386,000	----------	----	----------	----	----------	----	----------	----	----------	----	----------	----
1859	126,889	[2] 65,754	52	----------	----	8,150	6	33,379	26	11,134	9	8,472	7
1849	[1] 78,000	----------	----	----------	----	----------	----	----------	----	----------	----	----------	----
1839	[1] 38,000	----------	----	----------	----	----------	----	----------	----	----------	----	----------	----
1829	----------	----------	----	----------	----	----------	----	----------	----	----------	----	----------	----
1819	[1] 12,500	----------	----	----------	----	----------	----	----------	----	----------	----	----------	----
1810	[1] 3,000	500	17	630	21	----------	----	----------	----	650	22	1,220	40

[1] Estimated from values reported by the Bureau of the Census.
[2] Includes both newsprint and book paper.

TABLE 10.—*Source of the pulp wood required for the paper consumed in the United States.*

[Wood pulp and paper converted into cords of pulp wood of 128 cubic feet.]

Year.	United States paper consumption; pulp wood required.	Domestic pulp wood consumed.		Total imports (pulp wood, wood pulp, and paper).		Imported from— Canada (pulp wood, wood pulp, and paper).	
	Cords.	Cords.	Per cent consumption.	Cords.	Per cent consumption.	Cords.	Per cent consumption.
1922	9,148,000	4,498,000	49	4,885,000	53	3,374,000	37
1921	6,649,000	3,740,000	56	3,148,000	47	2,378,000	36
1920	8,300,000	5,015,000	61	3,718,000	44	3,149,000	38
1919	6,806,000	4,446,000	65	2,980,000	44	2,741,000	40
1918	6,366,000	4,505,000	71	2,555,000	40	2,523,000	40
1917	6,783,000	4,708,000	69	2,553,000	38	2,063,000	30
1914	5,886,000	3,642,000	62	2,429,000	42	1,630,000	28
1909	4,420,000	3,210,000	72	1,362,000	31	1,025,000	23
1904	3,259,000	2,476,000	76	921,000	28	763,000	23
1899	1,950,000	1,617,000	83	458,000	24	420,000	22

Year.	Imported from— Norway, Sweden, Finland, and Germany (wood pulp and paper).		Imported from— All other countries (wood pulp and paper).		Domestic exports (wood pulp and paper).	
	Cords.	Per cent consumption.	Cords.	Per cent consumption.	Cords.	Per cent consumption.
1922	1,449,000	16	62,000	----------	235,000	2
1921	727,000	11	43,000	----------	239,000	3
1920	534,000	6	35,000	----------	433,000	5
1919	231,000	4	8,000	----------	620,000	9
1918	14,000	----------	18,000	----------	694,000	11
1917	467,000	7	23,000	1	478,000	7
1914	759,000	13	40,000	1	185,000	4
1909	294,000	7	43,000	1	152,000	3
1904	71,000	2	87,000	3	138,000	4
1899	26,000	1	12,000	1	125,000	7

TABLE 11.—*Source of the wood pulp required in the paper consumption in the United States.*

[Pulp wood and paper converted into tons of wood pulp of 2,000 pounds.]

Year.	Total paper consumption; wood pulp required.	From domestic pulp wood.	Total imports (pulp wood, wood pulp, and paper).	Imported from—			Domestic exports (wood pulp and paper).
				Canada (pulp wood, wood pulp, and paper).	Norway, Sweden, Finland, and Germany (wood pulp and paper).	All other countries, (wood pulp and paper).	
1922	5,847,000	2,823,000	3,156,000	2,339,000	782,000	35,000	132,000
1921	4,345,000	2,351,000	2,123,000	1,655,000	443,000	25,000	129,000
1920	5,315,000	3,133,000	2,423,000	2,103,000	299,000	21,000	241,000
1919	4,497,000	2,840,000	2,019,000	1,901,000	114,000	4,000	362,000
1918	4,270,000	2,816,000	1,751,000	1,734,000	7,000	10,000	297,000
1917	4,467,000	2,992,000	1,759,000	1,503,000	241,000	15,000	284,000
1914	3,798,000	2,336,000	1,582,000	1,184,000	378,000	20,000	120,000
1909	2,753,000	1,977,000	875,000	702,000	150,000	23,000	99,000
1904	2,062,000	1,549,000	599,000	490,000	44,000	65,000	86,000
1899	1,147,000	975,000	259,000	237,000	15,000	7,000	87,000

TABLE 12.—*Source of paper consumed in the United States.*

[Pulp wood and wood pulp converted into tons of paper of 2,000 pounds.]

Year.	United States paper consumption.	Manufactured from domestic pulp wood.	Total imports (pulp wood, wood pulp, and paper).	Imported from—			Domestic exports (wood pulp and paper).
				Canada (pulp wood, wood pulp, and paper).	Norway, Sweden, Finland, Germany (wood pulp and paper).	All other countries, (wood pulp and paper).	
1922	8,003,000	3,865,000	4,318,000	3,200,000	1,070,000	48,000	180,000
1921	6,054,000	3,276,000	2,958,000	2,305,000	618,000	35,000	180,000
1920	7,861,000	4,632,000	3,584,000	3,110,000	443,000	31,000	355,000
1919	6,493,000	4,100,000	2,915,000	2,744,000	165,000	6,000	522,000
1918	6,387,000	4,212,000	2,619,000	2,593,000	10,000	16,000	444,000
1917	6,256,000	4,190,000	2,464,000	2,105,000	338,000	21,000	398,000
1914	5,496,000	3,381,000	2,290,000	1,713,000	547,000	30,000	175,000
1909	4,224,000	3,033,000	1,341,000	1,076,000	229,000	36,000	150,000
1904	3,050,000	2,291,000	886,000	725,000	65,000	96,000	127,000
1899	2,158,000	1,832,000	489,000	447,000	28,000	14,000	163,000

TABLE 13.—*Wood pulp required for the paper consumed in the United States.*

[Quantity in tons of 2,000 pounds.]

Year.	Total.	Mechanical.		Sulphite.		Soda.		Sulphate.	
	Tons.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
1922	5,847,000	2,582,000	44	2,278,000	39	406,000	7	581,000	10
1921	4,345,000	2,138,000	49	1,622,000	37	280,000	7	305,000	7
1920	5,315,000	2,408,000	45	2,135,000	40	421,000	8	354,000	7
1919	4,497,000	2,176,000	48	1,742,000	39	343,000	8	236,000	5
1918	4,270,000	1,977,000	47	1,765,000	41	302,000	7	226,000	5
1917	4,467,000	2,157,000	48	1,753,000	39	396,000	9	161,000	4
1914	3,798,000	1,715,000	45	1,578,000	42	342,000	9	163,000	4
1909	2,753,000	1,287,000	47	1,132,000	41	289,000	10	45,000	2
1904	2,062,000	1,041,000	50	837,000	41	184,000	9	----------	------
1899	1,147,000	557,000	49	422,000	36	168,000	15	----------	------

TABLE 14.—*Pulp wood required for the paper consumed in the United States.*

[Quantity in cords of 128 cubic feet, by pulp classes, with equivalents in cubic feet of standing timber.]

Year.	United States consumption.		Mechanical.		Sulphite.		Soda.		Sulphate.	
	Cords.	Equivalent in standing timber (M cubic feet).	Cords.	Equivalent in standing timber (M cubic feet).	Cords.	Equivalent in standing timber (M cubic feet).	Cords.	Equivalent in standing timber (M cubic feet).	Cords.	Equivalent in standing timber (M cubic feet.)
1922	9,148,000	1,070,000	2,592,000	303,000	4,577,000	535,000	759,000	89,000	1,220,000	143,000
1921	6,649,000	778,000	2,158,000	252,000	3,281,000	384,000	569,000	67,000	641,000	75,000
1920	8,300,000	971,000	2,416,000	283,000	4,302,000	503,000	838,000	98,000	744,000	87,000
1919	6,806,000	796,000	2,181,000	255,000	3,451,000	404,000	665,000	78,000	509,000	59,000
1918	6,366,000	745,000	1,764,000	206,000	3,476,000	407,000	651,000	76,000	475,000	56,000
1917	6,783,000	794,000	2,175,000	255,000	3,495,000	409,000	760,000	89,000	353,000	41,000
1914	5,886,000	689,000	1,753,000	205,000	3,109,000	364,000	684,000	80,000	340,000	40,000
1909	4,420,000	517,000	1,354,000	158,000	2,412,000	282,000	553,000	65,000	101,000	12,000
1904	3,259,000	381,000	1,402,000	164,000	1,635,000	191,000	222,000	26,000	----------	----------
1899	1,950,000	228,000	758,000	89,000	954,000	111,000	238,000	28,000	----------	----------

TABLE 15.—*Source of the pulp wood used to meet the soda wood-pulp requirements of the United States.*

[Wood pulp and paper converted into cords of pulp wood of 128 cubic feet.]

Year.	Total requirements.	Domestic pulp wood consumed.		Total imports (pulp wood, wood pulp, and paper).		Imported from—						Domestic exports (wood pulp, and paper).	
						Canada (pulp wood, wood pulp, and paper).		Norway, Sweden, Finland, and Germany (wood pulp, and paper).		All other countries (wood pulp, and paper).			
	Cords.	Cords.	Per cent consumption.	Cords.	Per cent consumption.	Cords.	Per cent imports.	Cords.	Per cent imports.	Cords.	Per cent imports.	Cords.	Per cent consumption.
1922	759,000	606,000	80	196,000	26	180,000	92	7,000	3	9,000	5	43,000	6
1921	569,000	493,000	87	128,000	22	118,000	92	5,000	4	5,000	4	52,000	9
1920	838,000	747,000	89	184,000	22	177,000	96	2,000	1	5,000	3	93,000	11
1919	665,000	641,000	96	161,000	24	160,000	99	----------	------	1,000	1	137,000	20
1918	651,000	678,000	104	78,000	12	73,000	94	----------	------	5,000	6	105,000	16
1917	760,000	754,000	99	99,000	13	92,000	93	1,000	1	6,000	6	93,000	12
1914	684,000	635,000	93	78,000	11	63,000	81	9,000	11	6,000	8	29,000	4
1909	553,000	550,000	99	39,000	7	23,000	59	11,000	28	5,000	13	36,000	6
1904	222,000	213,000	96	46,000	21	35,000	76	1,000	2	10,000	22	37,000	17
1899	238,000	236,000	99	27,000	11	20,000	74	4,000	15	3,000	11	25,000	10

TABLE 16.—*Source of the soda wood pulp utilized by the United States.*

[Pulp wood and paper converted into tons of wood pulp of 2,000 pounds.]

Year.	Total utilized.	From domestic pulp wood.	Total imports (pulp wood, wood pulp, and paper).	Imported from—			Domestic exports (wood pulp, and paper).
				Canada (pulp wood, wood pulp, and paper).	Norway, Sweden, Finland, and Germany (wood pulp, and paper).	All other countries (wood pulp, and paper).	
1922	406,000	324,000	104,000	96,000	3,000	5,000	22,000
1921	280,000	243,000	63,000	59,000	2,000	2,000	26,000
1920	421,000	375,000	93,000	89,000	1,000	3,000	47,000
1919	343,000	326,000	86,000	86,000	----------	----------	69,000
1918	302,000	318,000	36,000	34,000	----------	2,000	52,000
1917	396,000	391,000	51,000	48,000	----------	3,000	46,000
1914	342,000	317,000	39,000	31,000	5,000	3,000	14,000
1909	289,000	286,000	21,000	13,000	6,000	2,000	18,000
1904	184,000	178,000	25,000	20,000	----------	5,000	19,000
1899	168,000	168,000	13,000	10,000	2,000	1,000	13,000

TABLE 17.—*Source of the pulp wood used to meet the sulphate wood-pulp requirements of the United States.*

[Wood pulp and paper converted into cords of pulp wood of 128 cubic feet.]

Year.	Total requirements.	Domestic pulp wood consumed.		Total imports (pulp wood, wood pulp, and paper).		Imported from—						Domestic exports (wood pulp, and paper).	
						Canada (pulp wood, wood pulp, and paper).		Norway, Sweden, Finland, and Germany (wood pulp, and paper).		All other countries (wood pulp, and paper).			
	Cords.	Cords.	Per cent consumption.	Cords.	Per cent consumption.	Cords.	Per cent imports.	Cords.	Per cent imports.	Cords.	Per cent imports.	Cords.	Per cent consumption.
1922	1,220,000	501,000	41	773,000	63	341,000	44	421,000	55	11,000	1	54,000	4
1921	641,000	292,000	46	399,000	62	220,000	55	175,000	44	4,000	1	50,000	8
1920	744,000	397,000	53	446,000	60	288,000	65	154,000	34	4,000	1	99,000	13
1919	509,000	269,000	53	344,000	67	282,000	82	59,000	17	3,000	1	104,000	20
1918	475,000	295,000	62	265,000	56	254,000	96	9,000	3	2,000	1	85,000	18
1917	353,000	192,000	54	237,000	67	163,000	69	71,000	30	3,000	1	76,000	21
1914	340,000	112,000	33	241,000	71	98,000	41	133,000	55	10,000	4	13,000	4
1909	101,000	1,000	------	100,000	100	9,000	10	80,000	79	11,000	11	----------	------

TABLE 18.—*Source of the sulphate wood pulp utilized by the United States.*

[Pulp wood and paper converted into tons of wood pulp of 2,000 pounds.]

Year.	Total utilized.	From domestic pulp wood.	Total imports (pulp wood, wood pulp, and paper).	Imported from—			Domestic exports (wood pulp, and paper).
				Canada (pulp wood, wood pulp, and paper).	Norway, Sweden, Finland, and Germany (wood pulp, and paper).	All other countries (wood pulp, and paper).	
1922	581,000	230,000	376,000	173,000	198,000	5,000	25,000
1921	305,000	141,000	187,000	103,000	82,000	2,000	23,000
1920	351,000	189,000	209,000	135,000	72,000	2,000	47,000
1919	236,000	124,000	161,000	132,000	28,000	1,000	49,000
1918	226,000	141,000	125,000	119,000	5,000	1,000	40,000
1917	161,000	85,000	112,000	76,000	34,000	2,000	36,000
1914	163,000	57,000	112,000	46,000	62,000	4,000	6,000
1909	45,000	----------	45,000	3,000	37,000	5,000	----------

TABLE 19.—*Source of the pulp wood used to meet the sulphite wood-pulp requirements of the United States.*

[Wood pulp and paper converted into cords of pulp wood of 128 cubic feet.]

Year.	Total requirements.	Domestic pulp wood consumed.		Total imports (pulp wood, wood pulp, and paper).		Imported from—						Domestic exports (wood pulp, and paper).	
						Canada (pulp wood, wood pulp, and paper).		Norway, Sweden, Finland, and Germany (wood pulp and paper).		All other countries (wood pulp and paper).			
	Cords.	Cords.	Per cent consumption.	Cords.	Per cent consumption.	Cords.	Per cent imports.	Cords.	Per cent imports.	Cords.	Per cent imports.	Cords.	Per cent consumption.
1922	4,577,000	2,215,000	48	2,468,000	54	1,555,000	63	880,000	36	33,000	1	106,000	2
1921	3,281,000	1,918,000	58	1,477,000	45	1,074,000	73	376,000	25	27,000	2	114,000	3
1920	4,302,000	2,570,000	60	1,918,000	45	1,597,000	83	302,000	16	19,000	1	186,000	5
1919	3,451,000	2,327,000	67	1,391,000	40	1,217,000	87	172,000	13	2,000	------	267,000	7
1918	3,476,000	2,426,000	70	1,257,000	36	1,244,000	99	5,000	------	8,000	1	207,000	6
1917	3,495,000	2,473,000	71	1,234,000	35	850,000	69	375,000	30	9,000	1	212,000	6
1914	3,109,000	1,817,000	58	1,376,000	44	744,000	54	610,000	44	22,000	2	84,000	2
1909	2,412,000	1,733,000	72	751,000	31	533,000	71	193,000	26	25,000	3	72,000	3
1904	1,635,000	1,182,000	72	520,000	32	432,000	83	53,000	10	35,000	7	67,000	4
1899	954,000	715,000	75	291,000	31	267,000	91	18,000	6	6,000	3	52,000	6

TABLE 20.—*Source of the sulphite wood pulp utilized by the United States.*

[Pulp wood and paper converted into tons of wood pulp of 2,000 pounds.]

Year.	Total utilized.	From domestic pulp wood.	Total imports (pulp wood, wood pulp, and paper).	Imported from—			Domestic exports (wood pulp, and paper).
				Canada (pulp wood, wood pulp, and paper).	Norway, Sweden, Finland, and Germany (wood pulp, and paper).	All other countries (wood pulp, and paper).	
1922	2,278,000	1,101,000	1,230,000	774,000	440,000	16,000	53,000
1921	1,622,000	946,000	733,000	531,000	188,000	14,000	57,000
1920	2,135,000	1,273,000	954,000	794,000	151,000	9,000	92,000
1919	1,742,000	1,182,000	692,000	605,000	86,000	1,000	132,000
1918	1,765,000	1,235,000	632,000	626,000	2,000	4,000	102,000
1917	1,753,000	1,241,000	617,000	425,000	187,000	5,000	105,000
1914	1,578,000	971,000	648,000	332,000	305,000	11,000	41,000
1909	1,132,000	811,000	358,000	248,000	97,000	13,000	37,000
1904	837,000	608,000	262,000	217,000	27,000	18,000	33,000
1899	422,000	302,000	146,000	134,000	9,000	3,000	26,000

TABLE 21.—*Source of the pulp wood used to meet the mechanical wood-pulp requirements of the United States.*

[Wood pulp and paper converted into cords of pulp wood of 128 cubic feet.]

Year.	Total requirements.	Domestic pulp wood consumed.		Total imports (pulp wood, wood pulp, and paper).		Imported from—						Domestic exports (wood pulp, and paper).	
						Canada (pulp wood, wood pulp, and paper).		Norway, Sweden, Finland, and Germany (wood pulp, and paper).		All other countries (wood pulp, and paper).			
	Cords.	Cords.	P. ct. consumption.	Cords.	P. ct. consumption.	Cords.	P. ct. imports.	Cords.	P. ct. imports.	Cords.	P. ct. imports.	Cords.	P. ct. consumption.
1922	2,592,000	1,176,000	45	1,448,000	56	1,298,000	89	141,000	10	9,000	1	32,000	1
1921	2,158,000	1,037,000	48	1,144,000	53	966,000	84	171,000	15	7,000	1	23,000	1
1920	2,416,000	1,301,000	54	1,170,000	48	1,087,000	92	76,000	7	7,000	1	55,000	2
1919	2,181,000	1,209,000	55	1,084,000	50	1,082,000	100	------	------	2,000	------	112,000	5
1918	1,764,000	1,106,000	63	955,000	54	952,000	100	------	------	3,000	------	297,000	17
1917	2,175,000	1,289,000	59	983,000	45	958,000	97	20,000	2	5,000	1	97,000	4
1914	1,753,000	1,078,000	61	734,000	42	725,000	99	7,000	1	2,000	------	59,000	3
1909	1,354,000	926,000	68	472,000	35	460,000	97	10,000	2	2,000	1	44,000	3
1904	1,402,000	1,081,000	77	355,000	25	296,000	83	17,000	5	42,000	12	34,000	2
1899	758,000	666,000	88	140,000	18	133,000	95	4,000	3	3,000	2	48,000	6

TABLE 22.—*Source of the mechanical wood pulp utilized by the United States.*

[Pulp wood and paper converted into tons of wood pulp of 2,000 pounds.]

Year.	Total utilized.	From domestic pulp wood.	Total imports. (pulp wood, wood pulp, and paper).	Imported from—			Domestic exports (wood pulp and paper).
				Canada (pulp wood, wood pulp, and paper).	Norway, Sweden, Finland, and Germany (wood pulp and paper).	All other countries (wood pulp and paper).	
1922	2,582,000	1,168,000	1,446,000	1,296,000	141,000	9,000	32,000
1921	2,138,000	1,021,000	1,140,000	962,000	171,000	7,000	23,000
1920	2,408,000	1,296,000	1,167,000	1,085,000	75,000	7,000	55,000
1919	2,176,000	1,208,000	1,080,000	1,078,000	----------	2,000	112,000
1918	1,977,000	1,122,000	958,000	955,000	----------	3,000	103,000
1917	2,157,000	1,275,000	979,000	954,000	20,000	5,000	97,000
1914	1,715,000	991,000	783,000	775,000	6,000	2,000	59,000
1909	1,287,000	880,000	451,000	438,000	10,000	3,000	44,000
1904	1,041,000	763,000	312,000	253,000	17,000	42,000	34,000
1899	557,000	505,000	100,000	93,000	4,000	3,000	48,000

TABLE 23.—*Source of the wood pulp used in the book paper consumed in the United States.*

[Percentages of part of book paper made of wood pulp.]

Year.	United States consumption.	Equivalent of wood pulp used in book (75 per cent of total).	From domestic pulp wood.	Imported from—							Domestic exports (book).
				Canada.			Norway, Sweden, Finland, Germany.		All other countries.		
				Manufactured in U.S. from—		Book.	Manufactured in U.S. from wood pulp.	Book.	Manufactured in U.S. from wood pulp.	Book.	
				Pulp wood.	Wood pulp.						
	Tons.	*Tons.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1922	968,000	725,000	58	17	14	(1)	12	(1)	1	(1)	2
1921	707,000	530,000	74	15	10	(1)	4	(1)	1	(1)	4
1920	1,060,000	795,000	76	17	9	(1)	4	(1)	(1)	(1)	6
1919	838,000	630,000	90	17	4	(1)	1	(1)	--------	(1)	12
1918	800,000	600,000	94	12	2	(1)	(1)	------	--------	(1)	8
1917	846,000	635,000	97	10	------	(1)	--------	(1)	--------	(1)	7
1914	926,000	695,000	88	14	------	(1)	--------	(1)	--------	(1)	2

[1] Less than 1 per cent.

TABLE 24.—*Source of the wood pulp used in the paper board consumed in the United States.*

[Percentages of part of boards made of wood pulp.]

Year.	United States board consumption.		From domestic pulp wood.	Imported from—							Domestic exports (boards).
				Canada.			Norway, Sweden, Finland, and Germany.		All other countries.		
	Total.	20 per cent of total (representing wood pulp used).		Manufactured in United States from—		Boards.	Manufactured in United States from wood pulp.	Boards.	Manufactured in United States from wood pulp.	Boards.	
				Pulp wood.	Wood pulp.						
	Tons.	*Tons.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent*
1922	2,154,000	430,000	61	6	13	7	14	1	(1)	(1)	2
1921	1,641,000	330,000	70	6	11	5	10	1	(1)	--------	3
1920	2,301,000	460,000	71	5	12	8	5	1	(1)	(1)	2
1919	1,940,000	390,000	69	7	12	12	3	--------	(1)	(1)	3
1918	1,927,000	385,000	78	5	14	5	--------	--------	--------	--------	2

[1] Less than 1 per cent.

TABLE 25.—*Source of the wrapping paper consumed in the United States.*

[All pulp wood and wood pulp used in the manufacture of wrapping paper is converted into tons of 2,000 pounds of wrapping paper.]

Year.	United States consumption.	From domestic pulp wood.		Imported from—					
				Canada.					
				Manufactured in United States from—				Wrapping.	
				Pulp wood.		Wood pulp.			
	Tons.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.
1922	[2] 1,059,000	704,000	66	63,000	6	136,000	13	1,349	[3]
1921	770,000	545,000	71	43,000	5	83,000	11	3	[3]
1920	1,003,000	804,000	80	58,000	6	127,000	13	1,186	[3]
1919	825,000	684,000	83	55,000	7	103,000	13	2,369	[3]
1918	859,000	724,000	84	44,000	5	120,000	14	3,873	1
1917	814,000	658,000	81	43,000	5	110,000	14	1,969	[3]
1914	892,000	772,000	87	46,000	5	24,000	3	6,412	1

Year.	Imported from—				Domestic exports [1] (wrapping).	
	Norway, Sweden, Finland, and Germany.		All other countries.			
	Manufactured in United States from wood pulp.	Wrapping.	Manufactured in United States from wood pulp.	Wrapping.		
	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.
1922	144,000	14	28,063	3	1,000	[3]	3,503	[3]	22,367	2
1921	111,000	14	4,618	1	800	[3]	1,086	[3]	18,114	2
1920	52,000	5	831	[3]	3,000	[3]	454	[3]	43,599	4
1919	26,000	3	3	[3]	2,000	[3]	29	[3]	47,258	6
1918	3,000	[3]					98	[3]	35,846	4
1917	33,000	4	655	[3]			707	[3]	33,818	4
1914	39,000	4	12,638	1	700	[3]	1,490	[3]	10,318	1

[1] Includes paper bags (quantity estimated from value of domestic exports).
[2] Not exact total because of rounding off of all figures except those from the Bureau of Foreign and Domestic Commerce.
[3] Less than 1 per cent.

TABLE 26.—*Source of the newsprint paper consumed in the United States.*

[Reduced to paper tons of 2,000 pounds.]

Year.	United States consumption.	From domestic pulp wood.		Imported from—														Domestic exports (newsprint).	
				Canada.[1]						Norway, Sweden, Finland, and Germany.				All other countries.					
				Manufactured in United States from—				Newsprint.		Manufactured in United States from wood pulp.		Newsprint.		Manufactured in United States from wood pulp.		Newsprint.			
				Pulp wood.		Wood pulp.													
	Tons.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.	Tons.	Per cent consumption.
1922	[2] 2,451,000	828,000	34	277,000	11	204,000	8	896,312	37	137,000	6	128,147	5	2,000	[3]	4,809	[3]	25,825	1
1921	2,002,000	772,000	39	220,000	11	137,000	7	657,149	33	94,000	5	130,804	6	3,000	[3]	4,556	[3]	16,812	1
1920	2,196,000	931,000	43	285,000	13	224,000	10	679,309	31	69,000	3	49,103	2	3,000	[3]	1,457	[3]	45,889	2
1919	1,892,000	835,000	44	279,000	15	224,000	12	627,687	33	33,000	2	----------	----------	1,000	[3]	47	[3]	110,268	6
1918	1,760,000	771,000	44	214,000	12	254,000	14	595,849	34	21,000	1	166	[3]	----------	----------	255	[3]	96,739	5
1917	1,824,000	767,000	42	221,000	12	272,000	15	557,863	31	98,000	5	1,250	[3]	1,000	[3]	----------	----------	93,866	5
1914	1,576,000	775,000	49	298,000	19	150,000	10	310,397	20	96,000	6	4,991	[3]	2,000	[3]	87	[3]	60,789	4
1909	1,159,000	774,000	67	254,000	21	101,000	9	20,000	2	43,000	4	1,911	[3]	4,000	[3]	----------	----------	38,740	3
1904	883,000	635,000	72	191,000	22	61,000	7	1,000	[3]	23,000	3	1,000	[3]	3,000	[3]	----------	----------	32,159	4
1899	569,000	471,000	83	115,000	20	17,000	3	----------	----------	3,000	1	----------	----------	----------	----------	----------	----------	37,319	7

[1] Includes Newfoundland and Labrador.
[2] Not exact totals because of rounding off all figures except those from the Bureau of Foreign and Domestic Commerce.
[3] Less than 1 per cent.

TABLE 27.—*Dependence of the United States on countries other than Canada for wood pulp and paper.*

[Quantity in tons of 2,000 pounds and cords of 128 cubic feet.]

Year.	United States paper consumption.		Total imports from all countries except Canada.		Imported from—											
					Norway, Sweden, Finland, and Germany.						All other countries except Canada.					
					Total.		Wood pulp.		Paper.		Total.		Wood pulp.		Paper.	
	Tons.	Pulp wood required (cords).	Pulp wood required (cords).	Per cent United States consumption.	Pulp wood required (cords).	Per cent total imports.	Tons.	Pulp wood required (cords).	Tons.	Pulp wood required (cords).	Pulp wood required (cords).	Per cent total imports.	Tons.	Pulp wood required (cords).	Tons.	Pulp wood required (cords).
1922	8,003,000	9,148,000	1,511,000	17	1,449,000	96	601,765	1,202,000	169,358	247,000	62,000	4	11,054	21,000	28,800	41,000
1921	6,054,000	6,649,000	770,000	12	727,000	94	284,980	527,000	148,482	200,000	43,000	6	9,274	18,000	18,420	25,000
1920	7,861,000	8,300,000	569,000	7	534,000	94	242,253	462,000	57,671	72,000	35,000	6	8,900	15,000	15,580	20,000
1919	6,493,000	6,806,000	239,000	4	231,000	97	113,414	230,000	922	1,000	8,000	3	3,390	6,000	7,800	2,000
1918	6,387,000	6,366,000	32,000	1	14,000	45	6,534	13,000	396	1,000	18,000	55			12,449	18,000
1917	6,256,000	6,783,000	490,000	7	467,000	95	237,390	461,000	3,698	6,000	23,000	5	1,465	1,000	16,184	22,000
1914	5,496,000	5,886,000	799,000	14	759,000	95	348,940	705,000	31,189	54,000	40,000	5	9,890	20,000	12,741	20,000
1909	4,224,000	4,420,000	337,000	8	294,000	87	129,365	258,000	25,411	36,000	43,000	13	13,354	27,000	12,054	16,000
1904	3,050,000	3,259,000	158,000	5	71,000	45	43,398	70,000	929	1,000	87,000	55	5,189	8,000	59,021	79,000
1899	2,158,000	1,950,000	38,000	2	26,000	69	5,494	11,000	8,564	15,000	12,000	31	312	1,000	6,919	11,000

TABLE 28.—*United States imports from Canada*[1] *of pulp wood, wood pulp, and paper.*

[Quantity in tons of 2,000 pounds, and cords of 128 cubic feet.]

Year.	United States paper consumption.		Imported from Canada.			
			Total.		Pulp wood.[2]	
	Tons.	Pulp wood required (cords).	Pulp wood required (cords).	P. ct. consumption.	Cords.	P. ct. imports.
1922	8,003,000	9,148,000	3,374,000	37	1,050,000	31
1921	6,054,000	6,649,000	2,378,000	36	817,000	34
1920	7,861,000	8,300,000	3,149,000	38	1,099,000	35
1919	6,493,000	6,806,000	2,741,000	40	1,032,000	38
1918	6,387,000	6,366,000	2,523,000	40	745,000	29
1917	6,256,000	6,783,000	2,063,000	30	774,000	37
1914	5,496,000	5,886,000	1,630,000	28	830,000	51
1909	4,224,000	4,420,000	1,025,000	23	794,000	77
1904	3,050,000	3,259,000	763,000	23	574,000	75
1899	2,158,000	1,950,000	420,000	22	369,000	88

Year.	Imported from Canada.					
	Wood pulp.			Paper.		
	Tons.	Pulp wood required (cords).	P. ct. imports.	Tons.	Pulp wood required (cords).	P. ct. imports.
1922	645,416	1,120,000	33	926,977	1,204,000	36
1921	402,846	681,000	29	675,136	880,000	37
1920	655,144	1,129,000	36	720,439	921,000	29
1919	519,212	853,000	31	674,963	856,000	31
1918	571,675	973,000	39	606,132	805,000	32
1917	438,986	629,000	31	497,276	660,000	32
1914	316,735	422,000	26	282,279	378,000	23
1909	164,404	204,000	20	16,941	27,000	3
1904	113,585	183,000	24	11,879	6,000	1
1899	31,511	51,000	12	88		

[1] Includes Newfoundland and Labrador. [2] Imported pulp wood consumed by American mills.

TABLE 29.—*Rate of increase of imports to meet the United States paper consumption, 1899–1922.*

[Wood pulp and paper converted into cords of pulp wood.]

Pulp wood grouped by pulp processes.	Total pulp-wood requirements.[1]			Domestic pulp wood.[2]			Total imports.		
	Cords.	Yearly rate of increase.		Cords.	Yearly rate of increase.		Cords.	Yearly rate of increase.	
		Cords.	P. ct.		Cords.	P. ct.		Cords.	P. ct.
All pulp	9,148,000	313,000	16	4,498,000	125,000	8	4,885,000	192,000	42
Mechanical, sulphite	7,169,000	237,000	14	3,391,000	87,000	6	3,916,000	152,000	35
Soda	759,000	23,000	10	606,000	16,000	7	196,000	7,000	26
Sulphate[3]	1,220,000	110,000	32	501,000	49,000	44	773,000	67,000	28

Pulp wood grouped by pulp processes.	Imports from—					
	Canada.			All other countries.		
	Cords.	Yearly rate of increase.		Cords.	Yearly rate of increase.	
		Cords.	P. ct.		Cords.	P. ct.
All pulp	3,374,000	128,000	30	1,511,000	64,000	168
Mechanical, sulphite	2,853,000	107,000	27	1,063,000	45,000	145
Soda	180,000	7,000	35	16,000	391	6
Sulphate[3]	341,000	30,000	31	432,000	36,000	25

[1] Pulp wood required in the manufacture of the exports of wood pulp and paper not included.
[2] Includes pulp wood required in the manufacture of the exports of wood pulp and paper.
[3] Increase based upon 1914, when the use of sulphate wood pulp in the United States first became significant.

TABLE 30.—*Wood-pulp imports into the United States.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Bureau of Foreign and Domestic Commerce.]

Year.	Grand total.	Mechanical.	Total chemical.	Total sulphite.	Total sulphate.	Chemical unbleached.			Chemical bleached.		
						Unclassified.	Sulphite.	Sulphate.	Unclassified.	Sulphite.	Sulphate.
1922	[1] 1,258,961	215,811	[1] 1,043,150	712,088	330,337	.....	473,424	308,564	.....	238,664	21,773
1921	697,100	190,744	506,356	328,270	178,086	.....	233,064	174,004	.....	95,206	4,082
1920	906,297	233,148	673,149	473,175	199,974	.....	344,969	182,697	.....	128,206	17,277
1919	636,016	202,253	433,763	282,707	151,056	.....	239,952	145,911	.....	42,755	5,145
1918	578,209	185,478	392,731	270,211	122,520	.....	253,454	118,761	.....	16,757	3,759
1917	677,841	279,073	398,768	289,210	109,558	.....	248,173	107,933	.....	41,037	1,625
1916	683,765	262,517	421,248	.....	.....	368,302	.....	.....	52,946	.....	.....
1915	568,379	174,056	394,323	.....	.....	321,700	.....	.....	72,623	.....	.....
1914	675,564	217,256	458,308	.....	.....	330,270	.....	.....	128,038	.....	.....
1913	541,455	167,889	373,566	.....	.....	296,255	.....	.....	77,311	.....	.....
1912	539,790	185,443	354,347	.....	.....	277,201	.....	.....	77,146	.....	.....
1911	562,424	262,681	299,743	.....	.....	213,241	.....	.....	86,502	.....	.....
1910	506,776	224,184	282,592	.....	.....	205,745	.....	.....	76,847	.....	.....
1909	370,023	145,362	224,661	.....	.....	161,672	.....	.....	62,989	.....	.....
1908	[2] 250,485	[3] 71,217	[3] 78,733	.....	.....	[3] 59,670	.....	.....	[3] 19,063	.....	.....
1907	296,778	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1906	199,702	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1905	170,867	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1904	179,324	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1899	57,335	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1889	26,378	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Includes 725 tons of soda September to December only.
[2] Includes 100,535 tons of wood pulp, grade unclassified, imported Jan. 1 to June 30.
[3] July 1 to Dec. 31.

TABLE 31.—*Sulphate-pulp imports into the United States.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Bureau of Foreign and Domestic Commerce.]

Year.	Total.	Country of origin.										All other.	
		Canada.		Sweden.		Norway.		Germany.		Finland.			
	Tons.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
1922	330,337	153,784	46	137,250	42	9,912	3	2,044	1	26,467	8	880	.....
1921	178,086	100,496	57	64,626	36	3,867	2	2,463	1	6,495	4	139	.....
1920	199,974	128,156	64	58,253	30	3,766	2	595	.....	8,694	4	510	.....
1919	151,056	122,100	81	24,270	16	2,890	2	.....	.....	430	.....	1,366	1
1918	122,520	118,114	96	.....	.....	4,406	4	.....	.....	.....	.....	.....	.....
1917	109,558	90,360	82	16,010	15	2,862	3	.....	.....	.....	.....	326	.....

TABLE 32.—*Sulphite-pulp imports into the United States.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Bureau of Foreign and Domestic Commerce.]

Year.	Total.	Country of origin.										All other.	
		Canada.		Sweden.		Norway.		Germany.		Finland.			
	Tons.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
1922	712,088	301,322	42	266,065	37	76,481	11	22,534	3	36,999	5	8,687	2
1921	328,270	164,988	50	88,301	27	12,674	4	17,521	5	36,161	11	8,625	3
1920	473,175	328,969	70	90,435	19	19,110	4	8,280	2	21,090	4	5,291	1
1919	282,707	196,034	69	61,309	22	9,618	3	.....	.....	14,897	5	849	1
1918	270,211	268,083	99	784	.....	1,344	1	.....	.....	.....	.....	.....	.....
1917	289,210	136,873	47	127,409	44	22,354	8	.....	.....	.....	.....	2,574	1

TABLE 33.—*Mechanical-pulp imports into the United States.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Bureau of Foreign and Domestic Commerce.]

Year.	Total.	Country of origin.					
		Canada.[1]	Norway.	Sweden.	Finland.	Germany.	All others.
1922	215,811	190,310	9,227	6,367	4,975	3,478	1,454
1921	190,744	137,362	23,382	15,555	13,698	247	510
1920	233,148	198,019	11,385	7,830	12,815	----------	3,099
1919	202,253	201,078	----------	----------	----------	----------	1,175
1918	185,478	185,478	----------	----------	----------	----------	----------
1917	279,073	259,599	15,542	2,467	----------	----------	1,465
1916	262,517	261,862	22	112	----------	----------	521
1915	174,056	173,643	105	252	----------	----------	56
1914	217,256	216,812	28	154	----------	11	251
1913	167,889	165,606	739	1,385	----------	131	28
1912	185,443	180,721	659	3,788	----------	157	118
1911	262,681	230,823	9,460	13,473	----------	901	8,024
1910	224,184	217,385	2,733	482	----------	210	3,374
1909	145,362	142,226	2,654	112	----------	232	138

[1] Includes Newfoundland and Labrador.

TABLE 34.—*Pulp-wood and paper imports of the United States.*

[Quantity in tons of 2,000 pounds and cords of 128 cubic feet.]

Year.	Pulp wood.	Total paper.	Newsprint.		Book.[1]	
	Cords.	Value.	Tons.	Value.	Tons.	Value.
1922	1,044,816	$85,884,082	1,029,268	$72,354,266	3,061	$551,947
1921	1,081,634	84,749,961	792,509	79,125,355	1,057	394,902
1920	1,241,444	75,785,927	729,869	68,660,950	2,627	784,087
1919	1,047,299	48,327,588	627,734	43,674,294	146	112,219
1918	1,370,027	39,383,861	596,270	35,023,161	204	97,752
1917	1,031,934	36,125,401	559,113	30,929,628	459	164,021
1916	1,097,577	22,251,658	468,230	18,527,748	1,217	258,836
1915	975,974	18,171,940	368,409	14,138,651	3,555	445,634
1914	999,649	18,151,074	315,475	12,189,792	6,291	836,480
1913	1,034,885	14,772,279	219,844	8,549,062	5,950	926,653
1912	933,565	8,582,596	85,593	3,262,778	5,044	868,717
1911	889,257	7,620,984	55,830	2,096,105	6,166	1,109,753
1910	934,731	8,325,337	----------	----------	[2] 3,048	628,201
1909	907,963	7,394,427	----------	----------	[2] 1,104	258,125
1908	810,256	6,430,505	----------	----------	----------	----------
1907	827,089	7,655,680	----------	----------	----------	----------
1906	[3] 322,758	5,508,985	----------	----------	----------	----------
1905	----------	4,541,079	----------	----------	----------	----------
1904	----------	3,909,769	----------	----------	----------	----------
1903	----------	3,692,290	----------	----------	----------	----------
1902	----------	3,257,520	----------	----------	----------	----------
1901	----------	3,118,014	----------	----------	----------	----------
1900	----------	3,061,810	----------	----------	----------	----------
1895	----------	3,180,079	----------	----------	----------	----------
1890	----------	2,898,448	----------	----------	----------	----------
1885	----------	1,658,648	----------	----------	----------	----------
1880	----------	2,017,096	----------	----------	----------	----------
1875	----------	1,330,486	----------	----------	----------	----------
1870	----------	1,227,572	----------	----------	----------	----------

Year.	Pulp board.		Wrapping.		All other.
	Tons.	Value.	Tons.	Value.	Value.
1922	30,629	$1,543,746	32,915	$2,733,640	$8,700,483
1921	19,650	1,113,770	5,707	528,849	3,587,085
1920	43,222	2,659,993	2,471	460,289	3,280,608
1919	44,461	2,270,353	2,401	406,570	1,864,152
1918	----------	----------	3,971	541,866	3,721,082
1917	----------	----------	3,331	456,752	4,575,000
1916	----------	----------	3,552	280,952	3,184,122
1915	----------	----------	11,104	626,661	2,980,904
1914	----------	----------	20,540	1,156,591	3,968,211
1913	----------	----------	----------	735,857	4,590,707
1912	----------	----------	----------	846,500	3,604,601
1911	----------	----------	----------	----------	4,424,126
1910	----------	----------	----------	----------	7,697,136
1909	----------	----------	----------	----------	7,136,302

[1] Includes all other printing and surface-coated as given by Bureau of Foreign and Domestic Commerce.
[2] Surface-coated only.
[3] July 1 to Dec. 31 only.

TABLE 35.—*Average annual consumption of imported spruce and aspen by States, 1918–1922.*

State.	Spruce.		Aspen.	
	Imported (cords).	Per cent of distribution.	Imported (cords).	Per cent of distribution.
United States	806,588	100.0	141,991	100.0
Maine	126,211	15.7	45,607	32.1
Wisconsin	24,081	3.0	----------	----------
New York	437,427	54.2	63,904	45.0
Pennsylvania	94,460	11.7	31,946	22.5
New Hampshire	79,550	9.9	----------	----------
Michigan	29,319	3.6	----------	----------
Virginia	723	.1	----------	----------
Washington	240	----------	----------	----------
Vermont	6,613	.8	86	.1
Massachusetts	4,797	.6	314	.2
All other States	3,167	.4	134	.1

TABLE 36.—*Book-paper imports of the United States.*[1]

[Quantity in tons of 2,000 pounds. Calendar years.]

Year.	Total.	Country of origin.								
		Canada.	Belgium.	Norway.	Germany.	Sweden.	England	France.	Finland.	All other.
1922	3,061	217	244	3	491	96	399	41	1,135	435
1921	1,057	2	293	145	238	1	96	101	123	58
1920	2,627	350	308	649	351	573	93	50	----------	253
1919	146	3	4	----------	3	27	63	13	----------	33
1918	204	40	10	----------	----------	----------	90	13	----------	51
1917	459	40	93	3	----------	87	107	17	----------	112
1916	1,217	114	172	116	151	4	339	82	----------	239
1915	3,555	3	635	678	913	59	520	49	----------	698
1914	6,291	30	1,366	493	2,181	429	608	60	----------	1,124
1913	5,950	1	1,256	258	1,808	272	1,059	42	----------	1,254
1912	5,044	3	1,129	533	1,430	64	778	76	----------	1,031
1911	6,166	6	1,046	499	2,235	23	912	236	----------	1,209

[1] Includes all other printing and surface-coated reported by Bureau of Foreign and Domestic Commerce.

TABLE 37.—*Wrapping-paper imports of the United States.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Bureau of Foreign and Domestic Commerce.]

Year.	Total.	Country of origin.						
		Canada.	Sweden.	Germany.	Norway.	Spain.	Finland.	All other.
1922	32,915	1,349	16,271	4,773	4,808	34	2,211	3,469
1921	5,707	3	2,875	1,410	33	130	300	956
1920	2,471	1,186	491	121	----------	282	219	172
1919	2,401	2,369	3	----------	----------	18	----------	11
1918	3,971	3,873	----------	----------	----------	77	----------	21
1917	3,331	1,969	274	----------	381	668	----------	39
1916	3,552	1,233	1,358	----------	246	445	----------	270
1915	11,104	4,060	5,583	185	728	386	----------	162
1914	20,540	6,412	9,183	1,034	2,421	891	----------	599

TABLE 38.—*Newsprint-paper imports of the United States.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Bureau of Foreign and Domestic Commerce.]

Year.	Total tons.	Country of origin.											
		Canada.[1]		Sweden.		Germany.		Finland.		Norway.		All other.	
		Tons.	P.ct.	Tons.	P.ct.	Tons.	P.ct.	Tons.	P.ct.	Tons.	P.ct.	Tons.	P.ct.
1922	1,029,268	896,312	87	51,812	5	32,837	3	26,205	2	17,293	2	4,809	1
1921	792,509	657,149	83	48,933	6	39,013	5	22,664	3	20,194	2	4,556	1
1920	729,869	679,309	93	18,875	3	21,066	3	3,244	----	5,918	1	1,457	----
1919	627,734	627,687	100	----------	----	----------	----	----------	----	----------	----	47	----
1918	596,270	595,849	100	166	----	----------	----	----------	----	----------	----	255	----
1917	559,113	557,863	100	56	----	----------	----	----------	----	1,194	----	----------	----
1916	468,230	468,070	100	11	----	----------	----	----------	----	34	----	115	----
1915	368,409	366,921	100	403	----	30	----	----------	----	908	----	147	----
1914	315,475	310,397	99	963	----	463	----	----------	----	3,565	1	87	----
1913	219,844	218,794	100	258	----	168	----	----------	----	624	----	----------	----
1912	85,593	84,652	99	337	----	8	----	----------	----	596	1	----------	----
1911	55,830	54,478	98	519	1	42	----	----------	----	786	1	5	----

[1] Includes Newfoundland and Labrador.

TABLE 39.—*Wood-pulp and paper* [1] *exports from the United States.*

[Quantity in tons of 2,000 pounds and value. Calendar years. Source, Bureau of Foreign and Domestic Commerce.]

Year.	Total wood pulp.	Total paper.	Printing.		Newsprint.		Book.		Fine.	Wrapping.		Boards.	All other.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Value.	Tons.	Value.	Value.	Value.
1922	24,500	$24,152,567			25,825	$2,352,587	17,231	$3,608,976	$1,780,344	22,367	$3,220,695	$3,489,665	$9,700,300
1921	28,483	25,516,091			16,812	2,160,339	20,092	5,895,245	4,355,642	13,022	2,293,892	2,323,949	8,487,024
1920	32,133	58,793,979			45,889	5,970,127	47,558	13,776,464	8,908,230	30,632	6,994,381	5,553,094	17,591,683
1919	40,057	64,039,668			110,268	10,091,951	76,691	16,169,055	13,188,165	37,458	6,664,462	4,604,048	13,321,987
1918	22,324	39,714,978			96,739	7,978,296	49,610	8,710,940	6,113,498	29,950	4,828,856	3,055,255	9,028,133
1917	39,180	33,204,263			93,866	7,586,374	47,274	8,179,868	3,636,235	26,243	3,987,239	2,232,135	7,582,412
1916	40,023	27,501,127			76,736	4,126,617	62,073	8,069,812	2,490,055	41,837	4,025,388	1,924,105	6,865,150
1915	20,294	12,964,767			55,161	2,707,626	22,329	2,169,067	1,201,254	18,496	1,667,387	834,385	4,385,048
1914	12,337	10,117,139			60,789	2,983,344	15,130	1,568,960	1,096,615	7,408	522,951		3,945,269
1913	19,776	9,937,323			43,301	2,105,984	14,059	1,617,285	1,304,767	6,861	560,535		4,348,752
1912	14,189	11,203,819			55,568	2,690,225	13,452	1,440,992	1,290,309				5,782,293
1911	9,494	10,051,602			48,921	2,357,455	13,215	1,278,796	1,149,880				5,265,471
1910	8,361	9,219,432	52,442	$3,107,954					1,194,912				4,916,566
1909	8,953	8,544,849	48,740	2,832,793					1,243,460				4,468,596
1908	11,297	7,088,438	29,990	1,867,715					996,457				4,224,266
1907	12,419	8,516,725	38,240	2,319,303					1,213,087				4,984,335
1906	14,133	10,089,734	74,207	4,162,947					1,072,652				4,854,135
1905	13,190	8,551,577	60,719	3,267,632					949,318				4,334,627
1904	10,086	7,677,154	52,159	2,982,185					990,741				3,704,228
1903	15,276	7,221,625	46,994	2,485,418					826,965				3,909,242
1902	15,668	7,251,517	49,606	2,720,363					882,370				3,648,784
1901	23,494	7,324,073	57,270	3,145,493					640,371				3,538,209
1900	24,940	7,038,014	57,948	3,141,764					497,974				3,398,276
1895		2,412,763							112,231				2,300,532
1890		1,239,420							119,451				1,119,969
1885		1,088,516											
1880		1,223,791											
1875		677,631											
1870		478,547											

[1] Foreign exports are negligible in quantity; therefore do not enter into this report.

TABLE 40.—*Imports of wood pulp and specified grades of paper into the United States, by principal countries, for 1922.*

[Quantity in tons of 2,000 pounds. Source, Bureau of Foreign and Domestic Commerce.]

Country of origin.	Wood pulp.						Paper.					
	Mechanical.		Sulphite.		Sulphate.		Newsprint.		Wrapping.		Book.	
	Tons.	Per cent distribution.	Tons.	Per cent distribution.	Tons.	Per cent distribution.	Tons.	Per cent distribution.	Tons.	Per cent distribution.	Tons.	Per cent distribution.
All countries	215,811	100	712,088	100	330,337	100	1,029,268	100	32,915	100	3,061	100
Canada	190,310	88	301,322	42	153,784	46	896,312	87	1,349	4	217	7
Sweden	6,367	3	266,065	37	137,250	42	51,812	5	16,271	49	96	3
Norway	9,227	4	76,481	11	9,912	3	17,293	2	4,808	14	3	------
Finland	4,975	2	36,999	5	26,467	8	26,205	2	2,211	7	1,135	37
Germany	3,478	2	22,534	3	2,044	1	32,837	3	4,773	15	491	16
All other	1,454	1	8,687	2	880	------	4,809	1	3,503	11	1,119	37

TABLE 41.—*Pulp-wood prices in the United States.*

[Per cord f. o. b. mill, by species. Source, Bureau of the Census and the Forest Service.]

Year.	Average.	Spruce.		Hemlock.	Balsam fir.	Yellow pine.	Poplar.		Tamarack.	Gum.	Jack pine.	Cottonwood.	Pine.	Slabs and other mill waste.[1]
		Domestic.	Imported.				Domestic.	Imported.						
1922	$16.20	$18.11	$21.87	$11.64	$14.52	$9.51	$14.95	$17.99	$11.58	$15.32	$12.38	------	------	$10.43
1921	20.10	21.68	27.98	16.04	18.96	12.10	19.97	22.17	13.27	21.55	14.47	$11.08	------	9.07
1920	19.03	19.97	26.78	14.80	19.20	12.15	17.74	18.96	12.75	20.39	11.03	11.33	------	12.13
1919	15.95	17.20	20.85	11.02	15.65	11.71	17.84	18.02	9.78	18.20	9.88	8.42	------	9.66
1918	13.93	15.38	19.25	9.50	15.42	7.50	13.67	12.87	9.03	15.85	13.35	7.24	------	7.55
1917	11.10	11.98	16.52	7.96	12.16	5.26	9.69	11.03	6.35	11.44	10.45	8.94	------	6.14
1916	8.76	9.35	11.47	6.60	9.79	5.17	8.76	9.70	5.50	9.70	7.52	5.09	------	4.63
1914	8.81	9.45	11.73	6.93	------	------	8.26	9.46	------	------	------	------	------	4.83
1909	8.62	9.32	11.34	6.30	8.28	(1)	7.96	7.94	------	------	(1)	------	$6.25	4.66
1908	8.38	8.76	10.60	6.02	7.23	(1)	8.01	8.04	------	------	(1)	------	6.08	------
1907	8.17	8.55	9.60	5.68	7.59	(1)	7.85	8.44	------	------	(1)	------	6.45	------
1904	6.82	6.89	8.49	------	------	------	7.07	7.13	------	------	------	------	------	------
1899	4.95	4.82	6.51	------	------	------	4.66	4.52	------	------	------	------	------	------

[1] Included in pine.

TABLE 42.—*Pulp-wood, wood-pulp, and newsprint production and exports of Canada.*

[Quantity in tons of 2,000 pounds and cords of 128 cubic feet. Source, Dominion Bureau of Statistics unless otherwise noted.]

Year.	Pulp wood.			Wood pulp.		Newsprint.		Paper.	
	Production.	Consumption.	Export.	Production.	Export.	Production.	Export.	Production.	Export.[1]
	Cords.	*Cords.*	*Cords.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1922	3,923,940	2,912,608	1,011,332	2,150,251	818,247	1,081,364	959,514	1,366,815	1,006,627
1921	3,273,131	2,180,578	1,092,553	1,549,082	527,222	805,114	709,241	1,018,947	748,663
1920	4,024,826	2,777,422	1,247,404	1,960,102	819,985	875,696	761,945	1,214,951	826,887
1919	3,498,981	2,428,706	1,070,275	1,716,089	709,129	794,567	708,429	1,090,235	769,040
1918	3,560,280	2,210,744	1,349,536	1,557,193	583,911	734,783	636,534	967,724	674,138
1917	3,122,179	2,104,334	1,017,845	1,464,308	511,803	689,847	596,187	853,689	621,182
1916	2,833,119	1,764,912	1,068,207	1,296,084	558,899	[2] 608,000	526,163	------	536,948
1915	2,355,550	1,405,836	949,714	1,074,805	364,170	[2] 489,000	419,974	------	438,218
1914	2,196,884	1,224,376	972,508	934,700	------	[2] 415,000	------	------	------
1913	2,144,064	1,109,034	1,035,030	854,624	------	[2] 350,000	------	------	------
1912	1,846,910	866,042	980,868	682,632	------	[2] 256,000	------	------	------
1911	1,520,227	672,288	847,939	496,833	------	[2] 246,000	------	------	------
1910	1,541,628	598,487	943,141	474,604	------	[2] 161,000	------	235,150	------
1909	1,557,753	622,129	935,624	445,408	------	[2] 150,000	------	------	------
1908	1,325,085	482,777	842,308	363,079	------	------	------	------	------
1900	------	------	------	------	------	------	------	87,615	------

[1] To show total paper export on a tonnage basis it was necessary to estimate the tonnage involved in hanging, boards, felts, and all other paper.
[2] As reported by the Newsprint Service Bureau.

TABLE 43.—*Wood-pulp production of Canada.*

[Quantity in tons of 2,000 pounds. Calendar years. Source, Dominion Bureau of Statistics.]

Year.	Total.	Mechanical.	Sulphite.	Soda.	Sulphate.
1922	[1] 2,150,251	1,241,185	678,878	793	217,862
1921	1,549,082	931,560	[2] 481,984	4,201	131,337
1920	1,960,102	1,090,114	675,733	5,768	188,487
1919	1,716,089	950,902	562,115	4,597	158,475
1918	1,557,193	879,510	494,322	3,761	179,600
1917	1,464,308	923,731	374,894	4,136	[3] 161,547
1916	1,296,084	827,258	363,972	3,877	100,977
1915	1,074,805	743,776	235,474	3,150	92,405
1914	934,700	644,924	217,550	1,893	70,333
1913	854,624	600,216	183,552	2,572	68,284
1912	682,632	499,226	142,978	6,959	33,469
1911	496,833	362,321	110,391	24,121	----------
1910	474,604	370,195	95,987	8,422	----------
1909	445,408	325,609	114,926	4,873	----------
1908	363,079	278,570	82,331	2,178	----------

[1] Includes 11,533 tons screenings.
[2] Includes 5,055 tons reported as other fiber.
[3] Includes 154 tons other wood pulp.

TABLE 44.—*Quantity of standing timber in the United States, by regions.*

Region.	Total stand.			Saw timber.
	All kinds.	Pulp species.		
	Million cu. ft.	*Million cu. ft.*	*Million cords.*	*Million bd. ft.*
New England [1]	20,850	19,525	166.9	49,799
Middle Atlantic	24,897	19,024	162.6	44,857
Lake	50,584	38,700	330.8	110,110
Central	85,118	28,200	241.0	144,470
South Atlantic	96,158	71,550	611.5	220,577
Lower Mississippi	118,364	79,320	678.0	280,908
Rocky Mountain	61,893	51,800	442.7	223,141
Pacific Coast	287,724	105,000	897.4	1,141,031
Total United States proper	745,588	413,119	3,530.9	2,214,893
Southeast Alaska	22,000	19,540	167.0	80,128

[1] Contains no allowance for reduction in stand by spruce bud worm, which amounts to 40 per cent or about 27½ million cords in Maine.

TABLE 45.—*Total stand of timber of principal kinds suitable for pulp, by regions.*

[Millions of cords.

Kind of timber and principal present or prospective use for pulp.	New England.	Middle Atlantic.	Lake.	Central.	South Atlantic.	Lower Mississippi.	Rocky Mountain.	Pacific coast.	Total United States.	Southeast Alaska.
Sulphite, mechanical, and sulphate:										
Spruce and fir	[1]85.5	14.0	17.1	3.4	3.4	----	85.5	205.1	414.0	45.3
Hemlock	6.4	23.9	51.3	19.7	6.4	----	2.5	200.9	311.1	121.4
Jack pine	----	----	38.4	----	----	----	----	----	38.4	----
Total	91.9	37.9	106.8	23.1	9.8	----	88.0	406.0	763.5	166.7
Soda:										
Aspen and cottonwood	6.4	2.2	27.3	10.7	5.1	21.4	12.8	----	85.9	.2
Birch-beech-maple	29.0	80.3	136.8	102.6	16.2	16.3	----	----	381.2	.1
Yellow poplar	----	.7	----	29.9	15.4	1.0	----	----	47.0	----
Basswood	2.6	2.2	17.1	10.7	1.7	----	----	----	34.3	----
Red gum	----	.9	----	18.8	51.3	97.4	----	----	168.4	----
Black and tupelo gums	----	1.1	----	21.3	54.7	54.7	----	----	131.8	----
Total	38.0	87.4	181.2	194.0	144.4	190.8	12.8	----	848.6	.3
Sulphate: [2]										
Southern yellow pine	1.1	15.1	----	21.4	453.0	487.2	----	----	977.8	----
Tamarack and larch	.9	----	21.4	----	----	----	34.2	12.8	69.3	----
White and sugar pines	35.0	22.2	21.4	2.5	4.3	----	42.7	81.2	209.3	----
Western yellow pine	----	----	----	----	----	----	136.8	384.6	521.4	----
Lodgepole pine	----	----	----	----	----	----	128.2	12.8	141.0	----
Total	37.0	37.3	42.8	23.9	457.3	487.2	341.9	491.4	1,918.8	----
Regional total	166.9	162.6	330.8	241.0	611.5	678.0	442.7	897.4	3,530.9	167.0

[1] Contains no allowance for reduction in stand by spruce bud worm, which amounts to 40 per cent or about 27½ million cords in Maine.

[2] Contains no allowance for Douglas fir although a small volume is now being used. The stand is very large, probably two or three times that of pine and other species suitable for sulphate pulp.

TABLE 46.—*Forest areas,*[1] *by types and regions.*

[Millions of acres.]

Type of forest.	New England.	Middle Atlantic.	Lake.	Central.	South Atlantic.	Lower Mississippi.	Rocky Mountain.	Pacific coast.	Total United States.	Southeast Alaska.
Spruce-fir	10.0	2.4	4.5	0.5	0.5				17.9	
Northern pine	4.0	1.2	18.3						23.5	
Birch-beech-maple	9.5	9.8	19.7	2.0	2.1				43.1	
Oak-chestnut-poplar	1.8	12.7		29.1	10.1	2.7			56.4	
Oak-hickory			14.6	25.1		21.5			61.2	
Oak-pine	.4	2.6		1.7	29.4	22.0			56.1	
Southern pine					44.4	13.1			57.5	
Cypress-hardwoods				1.8	12.5	19.6			33.9	
Western white pine							2.5		2.5	
Douglas fir-spruce-hemlock							10.5	25.2	35.7	[2] 5.0
Lodgepole pine							20.2		20.2	
Western yellow pine							27.6	15.6	43.2	
Yellow pine-sugar pine								16.8	16.8	
Redwood								1.5	1.5	
Total	25.7	28.7	57.1	60.2	99.0	78.9	60.8	59.1	469.5	5.0

[1] These areas include all forest land within the several types, whether covered with merchantable timber, restocking with young timber, or devastated.
[2] The area given for Alaska is estimated, using length of timbered coast line as a basis.

TABLE 47.—*Present and possible annual growth of forest types of the United States, by State groups.*

[Figures in millions.]

Forest types.	Character of forest management.[1]	Total.		New England.[2]		Middle Atlantic.		Lake States.		Central.		South Atlantic.		Lower Mississippi.		Rocky Mountain.		Pacific coast.	
		Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.
Totals, entire United States	Present	6,039	9,874	479	895	507	774	536	1,073	1,106	1,745	1,483	2,124	938	1,465	279	404	711	1,394
	Crude, 1950	10,146	11,370	674	944	736	790	1,324	1,361	1,580	1,691	2,543	2,763	1,511	1,701	517	538	1,261	1,582
	Crude, ultimately	13,878	26,170	780	1,284	859	1,166	1,705	3,120	1,525	2,088	3,160	4,452	1,962	2,850	1,068	1,636	2,819	9,574
	Intensive	27,408	69,800	1,554	3,336	1,748	3,655	3,608	7,269	3,468	6,858	6,176	14,722	4,607	9,660	1,709	4,455	4,538	19,845
Spruce-fir	Present	199	287	124	186	36	54	23	23	8	12	8	12						
	Crude, 1950	355	300	194	183	56	53	80	40	13	12	12	12						
	Crude, ultimately	425	560	250	350	60	84	90	90	13	18	12	18						
	Intensive	761	1,200	450	750	108	180	159	194	22	38	22	38						
Birch-beech-maple	Present	563	795	163	195	170	204	150	300	40	48	40	48						
	Crude, 1950	1,146	950	239	197	249	206	540	450	59	49	59	48						
	Crude, ultimately	1,293	1,620	285	332	294	344	591	800	60	70	63	74						
	Intensive	2,586	3,900	570	810	588	840	1,182	1,880	120	190	126	180						
Pine	Present	353	990	148	444	32	96	173	450										
	Crude, 1950	656	1,200	178	493	38	107	440	600										
	Crude, ultimately	966	2,480	180	520	54	160	732	1,800										
	Intensive	1,984	5,900	400	1,460	120	435	1,464	4,005										

Oak-chestnut-yellow poplar.	Present	1,068	1,708	40	64	225	360			573	916	195	312	35	56				
	Crude, 1950	1,530	1,700	57	64	322	358			821	912	280	310	50	56				
	Crude, ultimately	1,692	2,200	54	70	381	500			873	1,130	303	400	81	100				
	Intensive	3,384	8,000	108	256	762	1,800			1,746	4,130	606	1,434	162	380				
Oak-pine	Present	860	1,173	4	6	44	60			35	48	489	666	288	393				
	Crude, 1950	1,377	1,300	6	7	71	66			56	53	783	738	461	436				
	Crude, ultimately	1,515	1,700	11	12	70	78			46	60	794	890	594	660				
	Intensive	3,647	8,500	26	60	170	400			110	260	1,911	4,450	1,430	3,330				
Southern pines	Present	831	1,108									636	848	195	260				
	Crude, 1950	1,600	1,800									1,225	1,378	375	422				
	Crude, ultimately	2,300	3,400									1,776	2,630	524	770				
	Intensive	3,738	9,500									2,886	7,330	852	2,170				
Cypress-southern hardwoods.	Present	333	686							26	52	115	238	192	396				
	Crude, 1950	534	800							42	61	184	277	308	462				
	Crude, ultimately	576	1,200							31	70	212	440	333	690				
	Intensive	1,695	3,500							90	190	625	1,290	980	2,020				
Oak-hickory	Present	842	1,329					190	300	424	669			228	360				
	Crude, 1950	1,170	1,200					264	271	589	604			317	325				
	Crude, ultimately	1,224	1,800					292	430	502	740			430	630				
	Intensive	3,366	5,000					803	1,190	1,380	2,050			1,183	1,760				
Western white pine	Present	51	136													51	136		
	Crude, 1950	65	100													65	100		
	Crude, ultimately	75	200													75	200		
	Intensive	150	400													150	400		
Lodgepole pine	Present	149	149													149	149		
	Crude, 1950	282	250													282	250		
	Crude, ultimately	404	360													404	360		
	Intensive	505	600													505	600		
Douglas fir-Engelmann spruce.	Present	32	53													32	53		
	Crude, 1950	71	100													71	100		
	Crude, ultimately	179	260													179	260		
	Intensive	368	700													368	700		
Western yellow pine	Present	79	104													47	66	32	38
	Crude, 1950	166	110													99	88	67	22
	Crude, ultimately	722	1,440													410	816	312	624
	Intensive	1,154	4,640													686	2,755	468	1,885
Douglas fir (Pacific coast).	Present	632	1,200															632	1,200
	Crude, 1950	1,058	1,200															1,058	1,200
	Crude, ultimately	2,066	7,500															2,066	7,500
	Intensive	2,822	14,360															2,822	14,360
Sugar and western yellow pine (California).	Present	29	76															29	76
	Crude, 1950	80	120															80	120
	Crude, ultimately	336	1,000															336	1,000
	Intensive	1,008	2,700															1,008	2,700
Redwood	Present	18	80															18	80
	Crude, 1950	56	240															56	240
	Crude, ultimately	105	450															105	450
	Intensive	240	900															240	900

[1] Under present forest management, new tree growth is largely volunteer. By "crude forestry, 1950," is meant the annual growth that may be expected by 1950 if such crude measures as fire protection and seed trees where needed are adopted immediately. By "crude forestry, ultimately" is meant the utmost growth that can finally be secured by these crude measures. By "intensive forestry" is meant an intensive management of forests as crops, comparable to forestry as practiced in some of the European countries.

[2] It is estimated by H. B. Peirson, forest entomologist of Maine, that the growth rate of the spruce-fir in that State is retarded about one-third as the result of the damage by the spruce bud worm. On this basis, the total cubic-foot and board-foot growth for New England would be reduced about 5 million and 4 million feet, respectively.

TABLE 48.—*Timber removed annually from the forests of the United States.*

Kind of material.	Unit of measure.	Quantity.	Equivalent in lumber which could have been sawed from same trees.			Equivalent in standing timber.			
			Hardwoods.	Softwoods.	Total.	Hardwoods.	Softwoods.	Total.	Per cent.
Grand total			*M board feet.* 19,135,920	*M board feet.* 41,057,780	*M board feet.* 60,193,700	*M cubic feet.* 11,259,860	*M cubic feet.* 13,525,640	*M cubic feet.* 24,785,500	100.00
Fuel wood	Cords	100,000,000	3,500,000	1,500,000	5,000,000	6,650,000	2,850,000	9,500,000	38.33
Lumber, dimension material and sawed ties	M board feet	37,700,000	9,425,000	28,275,000	37,700,000	2,064,075	6,192,225	8,256,300	33.31
Fencing	Number of posts	900,000,000	165,000	660,000	825,000	360,000	1,440,000	1,800,000	7.26
Ties, hewed	Number	70,000,000	1,680,000	420,000	2,100,000	672,000	168,000	840,000	3.39
Pulp wood	Cords	5,600,000	195,000	2,145,000	2,340,000	48,700	536,300	585,000	2.36
Mine timbers	Cubic feet	293,000,000	439,500	439,500	879,000	197,775	197,775	395,550	1.60
Cooperage:									
Tight staves	M staves	350,000	399,000	133,000	532,000	87,450	29,100	116,550	1.27
Tight heading	M sets	24,000	141,800	36,200	178,000	31,000	8,000	39,000	
Slack staves	M staves	1,200,000	240,400	121,600	362,000	52,800	26,400	79,200	
Slack heading	M sets	90,000	166,500	166,500	333,000	36,490	36,500	72,990	
Hoops	Thousands	120,000	21,500		21,500	7,080		7,080	
Shingles	Thousands	9,000,000		900,000	900,000		198,000	198,000	.80
Distillation wood	Cords	1,400,000	185,000		185,000	120,000	13,000	133,000	.54
Veneer logs	M feet log scale	576,000	587,520	103,680	691,200	90,000	15,980	105,980	.43
Tanning extract wood	Cords	1,000,000	87,000		87,000	95,000		95,000	.38
Poles	Number	4,250,000	55,000	200,000	255,000	11,700	43,550	55,250	.22
Vehicle stock, woodenware, handles, furniture, etc.	M board feet	200,000	197,700	2,300	200,000	45,070	730	45,800	.18
Piling	Number of pieces	1,500,000	40,000	140,000	180,000	7,800	31,200	39,000	.16
Excelsior wood	Cords	200,000	60,000	15,000	75,000	18,720	4,680	23,400	.09
Export logs and hewn timbers	M board feet	100,000	50,000	50,000	100,000	9,200	9,200	18,400	.07
Lath	Thousands	2,000,000							
Total			17,635,920	35,307,780	52,943,700	10,604,860	11,800,640	22,405,500	90.39
Destroyed by fire, insects, disease, and windfall		2,380,000	1,500,000	5,750,000	7,250,000	655,000	1,725,000	2,380,000	9.61

TABLE 49.—***Middle Atlantic States.***—*Stand of pulp species and growth, by forest types.* (*Million cords.*)

Species.	Stand.	Type of forest.	Growth.	
			Present.	Intensive forestry.
All species	212.8	Total	4.33	14.94
Pulp species	161.5	Spruce-fir	.31	.92
Spruce and fir	14.0	Birch-beech-maple	1.45	5.03
Hemlock	23.9	White pine	.27	1.03
Aspen and cottonwood	1.1	Oak mixtures	2.30	7.96
Birch, beech, maple	80.3			
Yellow poplar and basswood	2.9			
Gums	2.0			
Southern pines	15.1			
White pine	22.2			

TABLE 50.—***New York.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft.= 2 cords.	Cords.	Cords.
Spruce, fir	14,000,000	47	6,580,000	57,558	406,038	544,811
Hemlock	14,400,000	21	2,970,000	148,008	58,165	
Aspen or poplar	1,200,000	60	720,000	1,568	24,043	85,766
Beech, birch, and maple	75,000,000	20	15,000,000	299,854		

TABLE 51.—***Pennsylvania.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft.= 2 cords.	Cords.	Cords.
Spruce					21,123	122,306
Fir					16,000	
Hemlock	9,600,000	5	480,000	269,480	3,947	
Pitch pine	1,809,000	5	90,000	3,380	[1] 7,500	
Aspen or poplar	1,000,000	60	600,000	712	16,244	36,404

[1] Estimated, not reported separately by the Bureau of the Census.

TABLE 52.—***New England States.***—*Stand of pulp species and growth, by forest types.*

[Million cords.]

Species.	Stand.	Type of forest.	Growth.	
			Present.	Intensive forestry.
All species	178.2	Total	4.10	13.28
Pulp species	166.9	Spruce-fir	1.06	3.85
Spruce and fir	[1] 85.5	Birch-beech-maple	1.40	4.87
Hemlock	6.4	Pine	1.26	3.42
Aspen and cottonwood	6.4	Oak mixtures	.38	1.14
Birch, beech, maple	29.0			
Basswood and yellow poplar	2.6			
Pitch pine	1.1			
Tamarack	.9			
White pine	35.0			

[1] Contains no allowance for reduction in stand by spruce bud worm, which for Maine is estimated at 40 per cent or about 27½ million cords.

TABLE 53.—***Maine.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft. = 2 cords.	Cords.	Cords.
Spruce	[1] 60,000,000	50	30,000,000	329,304	1,019,601	93,581
Fir	[1] 9,000,000	50	4,500,000	62,084	61,585	
Hemlock	3,500,000	10	350,000	109,452	4,769	
Aspen or poplar	3,500,000	60	2,100,000	596	138,570	54,280

[1] Contains no allowance for reduction in stand by spruce bud worm, which is estimated at 40 per cent, or about 27½ million cords.

TABLE 54.—***New Hampshire.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft. = 2 cords.	Cords.	Cords.
Spruce	[1] 8,000,000	60	4,800,000	87,670	209,653	75,000
Fir	[1] 1,400,000	43	600,000	4,664	93,688	
Hemlock	1,200,000	11	135,000	47,016	2,806	
Aspen or poplar	1,550,000	40	620,000	1,640	191	

[1] Contains no allowance for loss by spruce bud worm.

TABLE 55.—***Vermont.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft. = 2 cords.	Cords.	Cords.
Spruce	6,000,000	43	2,600,000	51,924	100,426	10,097
Fir	375,000	95	355,000	8,880	4,892	
Hemlock	1,800,000	18	320,000	34,660	1,319	
Aspen or poplar	1,300,000	40	520,000	1,720	31	

TABLE 56.—***Lake States.***—*Stand of pulp species and growth, by forest types.*

[Million cords.]

Species.	Stand.	Type of forest.	Growth.	
			Present.	Intensive forestry.
All species	432.3	Total	4.58	30.84
Pulp species	330.8	Spruce-fir	.20	1.36
Spruce and fir	17.1	Birch-beech-maple	1.28	10.10
Hemlock	51.3	Pine	1.48	12.51
Jack pine	38.4	Oak-hickory	1.62	6.87
Aspen and cottonwood	27.3			
Birch, beech, maple	136.8			
Basswood and yellow poplar	17.1			
Tamarack	21.4			
White and Norway pines	21.4			

TABLE 57.—***Michigan.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft.= 2 cords.	Cords.	Cords.
Spruce	3,000,000	50	1,500,000	17,372	69,498	42,620
Fir	3,000,000	28	850,000	10,642	34,375	
Hemlock	19,000,000	13	2,500,000	413,680	63,190	
Aspen or poplar	8,000,000	40	3,200,000	10,908	1,333	
Jack pine	12,000,000	50	6,000,000		6,142	
Tamarack	[1] 3,600,000	20	720,000	24,914	16,384	

[1] 60 per cent sawfly-killed.

TABLE 58.—***Wisconsin.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft.= 2 cords.	Cords.	Cords.
Spruce	1,000,000	55	550,000	10,746	280,457	27,594
Fir	1,500,000	30	450,000	27,806	100,151	
Hemlock	32,000,000	20	6,400,000	806,650	472,115	
Aspen or poplar	5,000,000	40	2,000,000	14,928	1,102	
Jack pine	10,000,000	25	2,500,000		33,858	
Tamarack	[1] 3,600,000	20	720,000	23,530	43,031	

[1] 60 per cent sawfly-killed.

TABLE 59.—***Minnesota.***—*Stand of pulp species, lumber cut, and pulp-wood consumption.*

Species.	Total stand.	Approximate stand now available for pulp.		Lumber cut, 1920. (Cords.)	Consumption of pulp wood, 1920.	
					Domestic.	Imported.
	Cords.	Per cent of total.	Cords.	1 M ft.= 2 cords.	Cords.	Cords.
Spruce	5,000,000	48	2,400,000	62,984	243,471	
Fir	3,000,000	25	750,000	24,754	200	
Aspen or poplar	15,000,000	40	6,000,000	95,546	285	
Jack pine	16,000,000	40	6,400,000			
Tamarack	[1] 15,000,000	20	3,000,000	23,412	10,237	

[1] 60 per cent sawfly-killed.

TABLE 60.—***Pacific Coast States.***—*Stand of pulp species and growth, by forest types.*

[Million cords.]

Species.	Stand.	Type of forest.	Growth.	
			Present.	Intensive forestry.
All species	2,459.2	Total	6.08	38.79
Pulp species	897.4	Yellow pine	.27	4.00
Spruce and fir	205.1	Sugar-white pine	.25	8.62
Hemlock	200.9	Douglas fir	5.40	24.12
Larch	12.8	Redwood	.16	2.05
Sugar and white pine	81.2			
Yellow pine	384.6			
Lodgepole pine	12.8			

TABLE 61.—*Southern States.—Stand of pulp species and growth, by forest types.*

[Million cords.]

Species.	Stand.	Type of forest.	Growth.	
			Present.	Intensive forestry.
All species	1,833.5	Total	20.69	92.16
Pulp species	1,289.5	Spruce-fir	.67	.19
Spruce and fir	3.4	Birch-beech-maple	.34	1.08
Hemlock	6.4	Oak-chestnut-yellow poplar	1.97	6.56
Cottonwood	26.5	Oak-hickory	1.95	10.11
Birch, beech, maple	32.5	Oak-pine	6.64	28.55
Yellow poplar and basswood	18.1	Pine	7.10	31.95
Red gum	148.7	Hardwoods-cypress	2.02	13.72
Black and tupelo gums	109.4			
Yellow pine	940.2			
White pine	4.3			

TABLE 62.—*Rocky Mountain States.—Stand of pulp species and growth, by forest types.*

[Million cords.]

Species.	Stand.	Type of forest.	Growth.	
			Present.	Intensive forestry.
All species	529.0	Total	2.38	14.61
Pulp species	442.7	White pine	.44	1.28
Spruce and fir	85.5	Lodgepole pine	1.27	4.32
Hemlock	2.5	Douglas fir-spruce	.27	3.15
Aspen and cottonwood	12.8	Yellow pine	.40	5.86
Larch	34.2			
White pine	42.7			
Yellow pine	136.8			
Lodgepole pine	128.2			

TABLE 63.—*Central States.—Stand of pulp species and growth, by forest types.*

[Million cords.]

Species.	Stand.	Type of forest.	Growth.	
			Present.	Intensive forestry.
All species	727.6	Total	9.45	29.64
Pulp species	241.0	Spruce-fir	.07	.19
Spruce and fir	3.4	Birch-beech-maple	.34	1.03
Hemlock	19.7	Oak-chestnut-yellow poplar	4.90	14.92
Aspen and cottonwood	10.7	Oak-pine	.30	.94
Birch, beech, maple	102.6	Oak-hickory	3.62	11.79
Yellow poplar and basswood	40.6	Cypress-hardwoods	.22	.77
Red gum	18.8			
Black and tupelo gums	21.3			
Yellow pine	21.4			
White pine	2.5			

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